CMR Institute of Technology, Bangalore		
Department(s):		
Semester: 05	Section(s): TCE &DIP-1&2	
Engineering Mathematics-IV	15MAT-41	Lectures/week: 05
Course Instructor(s): Thulasi.L		
Course duration: 01 Jan., 2018 – 25 May 2018		

Course Objectives

- Define the basics of simulation modeling and replicating the practical situations in organizations
- Develop simulation model using heuristic methods.
- Generate random numbers and random variates using different techniques.
- Analysis of Simulation models using input analyzer, and output analyzer
- Explain Verification and Validation of simulation model.

Prerequisites

- Probability distributions and random variables
- Object Oriented Modeling Concepts
- Operation research

LESSON PLAN

Lecture #	Book & Sections	Topics	Portions coverage	
			Teaching Aids	% of Syllabus Covered
1-8	TB1: - 1.1, 2.1- 2.5	**UNIT – 1 INTRODUCTION :** When simulation is the appropriate tool and when it is not appropriate, Advantages and disadvantages of Simulation, Areas of application, Systems and system Environment , Components of a system- Discrete and continuous systems, Model of a system, Types of Models, Discrete-Event System Simulation, Steps in a Simulation Study, The basics of SpreadSheet-Simulation, Simulation Example: Simulation of queuing systems in a spreadsheet	Chalk and Talk Video Lectures for some topics	15
Links to some useful online lectures: ➢ http://nptel.ac.in/courses/112107214/2 ➢ https://www.youtube.com/watch?v=QppldN-t4pQ				
9-16	TB1 3.1 - 3.2 4.4- 4.5	**UNIT-2 -General Principles, Simulation Software :** Concepts in Discrete-Event Simulation, The Event-Scheduling / Time-Advance Algorithm, World Views Manual simulation Using Event Scheduling ,List processing ,Basic properties, Operations-Using Arrays, Dynamic Allocation ,Linked Lists-Simulation in Java - Simulation in GPSS	Chalk and Talk Video Lectures for some topics	15
Links to some useful online lectures: ➢ https://www.youtube.com/watch?v=UUQ-kDbhw_M				

➢ https://www.youtube.com/watch?v=maH8ormsIeU				
17-21	TB1 5.1 - 5.6	**UNIT 3- Statistical Models in Simulation:**Review of terminology, concepts, Useful statistical models, Discrete Distributions ,Continuous Distributions, Poisson Process, Empirical distributions.	Chalk and Talk	10
Links to some useful online lectures: ➢ https://www.youtube.com/watch?v=IDc48fCRwuw ➢ https://www.youtube.com/watch?v=Nj_HjNRE6-U				
22-30	TB1 7.1- 7.4 8.1 -8.3	**UNIT 5- Random-Number Generation, Random-Variate Generation** Properties of random numbers, Generation of pseudo-random numbers ,Techniques for generating random numbers ,Tests for Random Numbers, Random- Variate Generation ,Inverse transform technique ,Acceptance-Rejection technique, Special properties	Chalk and Talk Video Lectures for some topics	20
Links to some useful online lectures: ➢ https://www.youtube.com/watch?v=cTXKnif_h1o ➢ https://www.youtube.com/watch?v=Q11uUTA-ndY				
31-36	TB1 9.1 - 9.7	**UNIT 6 -Input Modeling:** Data Collection ,Identifying the distribution with data, Parameter Estimation, Goodness of Fit Tests, Fitting a non-stationary Poisson process ,Selecting input models without data , Multi-variate and Time-Series input models	Chalk and Talk	10
Links to some useful online lectures: ➢ https://www.youtube.com/watch?v=YdbxIDvid1I ➢ https://www.youtube.com/watch?v=2nv8XMluWrU				
37-42	TB1 11.1-11.5	**UNIT 7 –Estimation Of Absolute performance[Output Analysis For A Single Model :** Types of simulations with Respect to Output analysis , Stochastic Nature of Output Data, Measures of Performance and their Estimation ,Output Analysis for Terminating Simulations, Output analysis for steady-State Simulations. Problems	Chalk and Talk	10
Links to some useful online lectures: ➢ https://cs.wmich.edu/alfuqaha/Spring10/cs6910/lectures/Chapter11.pdf				
43-48	TB1 10.1 - 10.3 & 12.4	**UNIT - 8 -Verification, Calibration, and Validation; Optimization of simulation Models :** Model Building, Verification, Validation, Verification of simulation models, Calibration, Validation of models , Optimization, Optimization via Simulation	Chalk and Talk	10
Links to some useful online lectures: ➢ https://www.youtube.com/watch?v=nLf-DtkoDb4 ➢ nptel.ac.in/courses/112107214/35				
49-52	TB1 6.1- 6.7	**UNIT 4 - Queuing Models:** Characteristics of queuing Systems, Queuing notation , Long-run measures of performance of queuing Systems, Steady-state behavior of	Chalk and Talk	10

		M/G/1 queue, Networks of queues ,Rough-cut modeling: An illustration		

Links to some useful online lectures:

- https://www.youtube.com/watch?v=xGkpXk-AnWU
- https://www.youtube.com/watch?v=2aPlzhsEsIw

Text Books	
1.	Jerry Banks, John S. Carson II, Barry L. Nelson, David M. Nicol: Discrete-Event System Simulation. (Listed topics only from Chapters-1 to 12), 5th Edition, Pearson Education ©2013
Reference Books	
1.	Averill M. Law: Simulation Modeling and Analysis , 4th Edition, Tata McGraw-Hill, 2007.ISBN : 9780070667334
2.	Lawrence M. Leemis, Stephen K. Park: Discrete – Event Simulation: A First Course, Pearson Education, 2006.ISBN: 978-0131429178

Syllabus for Internal Assessment Tests (IAT)*

IAT #	Syllabus
IAT-1	Class # 01 – 18
IAT-2	Class # 19– 37
IAT-3	Class # 38– 52

* : See calendar of events for the schedules of IATs.

Course Outcomes
By the end of this course, students will be able to
1. Describe the role of important elements of discrete event simulation and modeling paradigm.
2. Conceptualize real world situations related to systems development decisions, originating from source requirements and goals.
3. Interpret the model and apply the results to resolve critical issues in a real world environment.
4. Apply random number variates to develop simulation models
5. Analyze output data produced by a model and test validity of the model
6. Explain the concepts of verification and validation

COGNITIVE LEVELS	
Cognitive level	**REVISED BLOOMS TAXONOMY KEYWORDS**
L1	List, define, tell, describe, identify, show, label, collect, examine, tabulate, quote, name, who, when, where, etc.
L2	summarize, describe, interpret, contrast, predict, associate, distinguish, estimate, differentiate, discuss, extend
L3	Apply, demonstrate, calculate, complete, illustrate, show, solve, examine, modify, relate, change, classify, experiment, discover.
L4	Analyze, separate, order, explain, connect, classify, arrange, divide, compare, select, explain, infer.
L5	Assess, decide, rank, grade, test, measure, recommend, convince, select, judge, explain, discriminate, support, conclude, compare, summarize.

PROGRAM OUTCOMES (PO), PROGRAM SPECIFIC OUTCOMES (PSO)	
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.
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.
PSO1	Design, implement and maintain business applications in a variety of languages using libraries and frameworks.
PSO2	Develop and simulate wired and wireless network protocols for various network applications using modern tools.
PSO3	Apply the knowledge of software and design of hardware to develop embedded systems for real

	world applications.
PSO4	Apply knowledge of web programming and design to develop web based applications using database and other technologies

CORRELATION LEVELS	
0	No Correlation
1	Slight/Low
2	Moderate/ Medium
3	Substantial/ High

Course Outcomes		**Modules covered**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	Describe the role of important elements of discrete event simulation and modeling paradigm.	**1**	2	2	1	1	-	1	-	-	-	-	-	1	1	-	1	-
CO2	Conceptualize real world situations related to systems development decisions, originating from source requirements and goals.	**1,2**	2	3	-	1	-	1	2	1	2	-	-	2	1	-	1	-
CO3	Interpret the model and apply the results to resolve critical issues in a real world environment.	**2,3,4**	2	3	2	2	2	2	1	-	1	-	-	1	1	-	1	-
CO4	Apply random numbers and variates to develop simulation models	**5,6**	1	2	1	-	2	1	-	-	-	-	-	1	1	-	1	-
CO5	Analyze output data produced by a model and test validity of the model	**7**	2	2	-	-	2	-	-	-	-	-	-	2	1	-	1	-
CO6	Explain the concepts of verification and validation	**8**	-	-	-	-	1	-	-	- -	-	-	-	-	1		1	

Note : From time to time, assignments will be posted on

https://sites.google.com/a/cmrit.ac.in/swathi-4950

CMR Institute of Technology, Bangalore		
Department(s): Electronics and Communication Engineering		
Semester: 04	Section(s): A&B	
Micoprocessors	10EC42	Lectures/week: 04
Course Instructor(s): Sutapa Sarkar, Manjunath V, Hemanth		
Course duration: 01 Jan., 2018 – 25 May 2018		

Course Objectives

- Familiarize basic architecture of 8086 microprocessor
- Program 8086 Microprocessor using Assembly Level Language
- Use Macros and Procedures in 8086 Programs
- Understand interfacing of 16 bit microprocessor with memory and peripheral chips involving system design
- Understand the architecture of 8088, 8087 Coprocessor and other CPU architectures

Prerequisites

- Basics of number system
- Basic knowledge in the area of computer hardware and processing systems

LESSON PLAN

Lecture #	Book & Sections	Topics	Portions coverage	
			Teaching Aids	% of Syllabus Covered
1-9	TB1: - 1.1 – 1.3, 2.2, 2.1, 3.2, 2.3	**UNIT – 8086 PROCESSOR:** Historical background (refer Reference Book 1), 8086 CPU Architecture Addressing modes, Machine language instruction formats,Machine coding the program **INSTRUCTION SET OF 8086:** Data transfer and arithmetic instructions. Control/Branch Instructions, Illustration of these instructions with example programs.	Chalk and Talk Video Lectures for some topics	20
Links to some useful online lectures: ➢ 8086 pin configuration ➢ Addressing modes				
10-18	TB1 2.3, 2.4, 3.4	**UNIT-2 -** Logical Instructions, String manipulation instructions, Flag manipulation and Processor control instructions, Illustration of these instructions with example programs. Assembler Directives and operators, Assembly Language Programming and example programs.	Chalk and Talk Video Lectures for some topics	20
Links to some useful online lectures: ➢ Instruction Sets				

➢ Arithmetic Instructions ➢ String Manipulation Instructions				
19-28	TB1 4.0	**UNIT 3- Stack and Interrupts:** Introduction to stack, Stack structure of 8086, Programming for Stack. Interrupts and Interrupt Service routines, Interrupt cycle of 8086, NMI, INTR, Interrupt programming, Passing parameters to procedures, Macros, Timing and Delays.	Chalk and Talk	20
Links to some useful online lectures: ➢ Procedures and Macros ➢ Interrupts				
29-40	TB1 1.4-1.9,5.3-5.5	**UNIT 4** **8086 Bus Configuration and Timings:** Physical memory Organization, General Bus operation cycle, I/O addressing capability, Special processor activities, Minimum mode 8086 system and Timing diagrams, Maximum Mode 8086 system and Timing diagrams. **Basic Peripherals and their Interfacing with 8086 (Part 1)**: Static RAM Interfacing with 8086 (5.1.1), Interfacing I/O ports, PIO 8255, Modes of operation – Mode-0 and BSR Mode, Interfacing Keyboard and 7-Segment digits using 8255	Chalk and Talk Video Lectures for some topics	20
Links to some useful online lectures: ➢ 8255 ➢ Minimum Mode ➢ Maximum mode				
41-49	TB1 5.6.1, 5.7.2, 5.8,6.1, Appendix-B, 1.10 - 1.10.1, 8.3.1-8.3.5, RF1	**UNIT 5 -Basic Peripherals and their Interfacing with 8086 (Part 2):** Interfacing ADC-0808/0809, DAC-0800, Stepper Motor using 8255) Timer 8254 – Mode 0, 1, 2 & 3 and Interfacing programmes for these modes. **INT 21H DOS Function calls** - for handling Keyboard and Display (refer Appendix-B of Text). **Other Architectures**: Architecture of 8088 (refer 1.10 upto 1.10.1 of Text) and Architecture of NDP 8087 (refer 8.3.1, 8.3.5 of Text). Von-Neumann & Harvard CPU architecture and CISC & RISC CPU architecture (refer Reference Book 1).	Chalk and Talk	20
Links to some useful online lectures: ➢ INT 21H ➢ Von-Neumann & Harvard CPU architecture				

Text Books	
1.	**Advanced Microprocessors and Peripherals** - A.K. Ray and K.M. Bhurchandi, TMH, 3rd Edition, 2012, ISBN 978-1-25-900613-5.
Reference Books	
7.	**Microprocessor and Interfacing** - Douglas V Hall, SSSP Rao, 3rd edition TMH, 2012.
8.	**Microcomputer systems-The 8086 / 8088 Family** – Y.C. Liu and A. Gibson, 2nd edition, PHI - 2003.
9.	**The 8086 Microprocessor: Programming & Interfacing the PC –** Kenneth J Ayala, CENGAGE Learning, 2011.

10.	**The Intel Microprocessor, Architecture, Programming and Interfacing -** Barry B. Brey, 6e, Pearson Education / PHI, 2003.

Syllabus for Internal Assessment Tests (IAT)*

IAT #	Syllabus
IAT1	Class # 01 –18
IAT2	Class # 19- 35
IAT3	Class # 36– 51,

* : See calendar of events for the schedules of IATs.

Course Outcomes
By the end of this course, students will be able to
1. Explain the History of evaluation of Microprocessors, Architecture of 8086, 8088, 8087, CISC & RISC, Von-Neumann & Harvard CPU architecture
2. Write 8086 Assembly level programs using the 8086 instruction set
3. Write modular programs using procedures and macros.
4. Write 8086 Stack and Interrupts programming
5. Interface 8086 to Static memory chips and 8255, 8254, 0808 ADC, 0800 DAC, Keyboard, Display and Stepper motors.
6. Use INT 21 DOS interrupt function calls to handle Keyboard and Display

COGNITIVE LEVELS	
Cognitive level	**REVISED BLOOMS TAXONOMY KEYWORDS**
L1	List, define, tell, describe, identify, show, label, collect, examine, tabulate, quote, name, who, when, where, etc.
L2	summarize, describe, interpret, contrast, predict, associate, distinguish, estimate, differentiate, discuss, extend
L3	Apply, demonstrate, calculate, complete, illustrate, show, solve, examine, modify, relate, change, classify, experiment, discover.
L4	Analyze, separate, order, explain, connect, classify, arrange, divide, compare, select, explain, infer.
L5	Assess, decide, rank, grade, test, measure, recommend, convince, select, judge, explain, discriminate, support, conclude, compare, summarize.

PROGRAM OUTCOMES (PO), PROGRAM SPECIFIC OUTCOMES (PSO)	
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.
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.
PSO1	
PSO2	
PSO3	

CORRELATION LEVELS	
0	No Correlation
1	Slight/Low
2	Moderate/ Medium
3	Substantial/ High

Course Outcomes		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Explain the History of evaluation of Microprocessors, Architecture of 8086, 8088, 8087, CISC & RISC, Von-Neumann & Harvard CPU architecture	3	1	-	-	-	-	-	-	-	-	-	2	-	1	-
CO 2	Write 8086 Assembly level programs using the 8086 instruction set	3	3	2	-	-	-	-	-	-	-	-	2	-	1	-
CO 3	Write modular programs using procedures and macros.	3	3	2	-	-	-	-	-	-	-	-	2	-	1	-
CO 4	Write 8086 Stack and Interrupts programming	3	3	2	-	-	-	-	-	-	-	-	2	-	1	-
CO 5	Interface 8086 to Static memory chips and 8255, 8254, 0808 ADC, 0800 DAC, Keyboard, Display and Stepper motors.	3	3	2	-	-	-	-	-	-	-	-	2	1	-	-
CO 6	Use INT 21 DOS interrupt function calls to handle Keyboard and Display	3	3	2	-	-	-	-	-	-	-	-	2	-	-	-

Note : From time to time, assignments will be posted on

https://sites.google.com/a/cmrit.ac.in/swathi-4950

CMR Institute of Technology, Bangalore		
Department(s): Telecommunication Engineering		
Semester: 04	Section(s): A	
Control Systems	15EC43	Lectures/week: 05
Course Instructor(s): Richa Tengshe		
Course duration: 05 Jan., 2018 – 25 May 2018		

Course Objectives

- Know the basic features, configurations and application of control systems.
- Know various terminologies and definitions for the control systems.
- Learn how to find a mathematical model of electrical, mechanical and electro-mechanical systems.
- Know how to find time response from the transfer function.
- Find the transfer function via Mason's rule.
- Analyze the stability of a system from the transfer function.

Prerequisites

- Basics of Signals and Systems, LTI Systems, Difference Equations, Convolution
- Basics of Laplace Transform
- Basics of Complex numbers

LESSON PLAN

Lecture #	Book & Sections	Topics	Portions coverage	
			Teaching Aids	% of Syllabus Covered
1-12	TB1, Chapter 1,2,3	Introduction to Control Systems: Types of Control Systems, Effect of Feedback Systems, Differential equation of Physical Systems – Mechanical Systems, Electrical Systems, Analogous Systems. Block diagrams and signal flow graphs: Transfer functions, Block diagram algebra and Signal Flow graphs.	Chalk and Talk	20

Links to some useful online lectures:

- https://www.youtube.com/watch?v=oBc_BHxw78s&list=PLUMWjy5jgHK1NC52DXXrriwihVrYZKqjk
- https://www.youtube.com/watch?v=3eDDTFcSC_Y&index=4&list=PLUMWjy5jgHK1NC52DXXrriwihVrYZKqjk
- https://www.youtube.com/watch?v=vVFDm__CdQw
- https://www.youtube.com/watch?v=u6kYU3qcR3c
- https://ocw.mit.edu/resources/res-6-010-electronic-feedback-systems-spring-2013/course-videos/lecture-1-introduction-and-basic-concepts/
- https://in.mathworks.com/videos/understanding-control-systems-part-1-open-loop-control-systems-123419.html
- https://in.mathworks.com/videos/understanding-control-systems-part-2-feedback-control-systems-123501.html

13-24	TB1, Chapter 5	Time Response of feedback control systems: Standard test signals, Unit step response of First and Second order Systems. Time response specifications, Time response specifications of second order systems, steady state errors and error constants. Introduction to PI, PD and PID Controllers	Chalk and Talk	20
Links to some useful online lectures: ➢ https://www.youtube.com/watch?v=UR0hOmjaHp0&index=28&list=PLUMWjy5jgHK1NC52DXXrriwihVrYZKqjk https://www.youtube.com/watch?v=Eg8_4qjuD3Q&index=5&list=PL692A7B9169289C4F				
25-36	TB1, Chapter 6,7	Stability analysis: Concepts of stability, Necessary conditions for Stability, Routh stability criterion, Relative stability analysis: more on the Routh stability criterion, Introduction to Root-Locus Techniques, The root locus concepts, Construction of root loci.	Chalk and Talk	20
Links to some useful online lectures: ➢ https://www.youtube.com/watch?v=cJRlUGDtS-0&index=23&list=PL692A7B9169289C4F ➢ https://ocw.mit.edu/resources/res-6-010-electronic-feedback-systems-spring-2013/course-videos/lecture-4-stability/ ➢ https://www.youtube.com/watch?v=uqjKG32AkC4&list=PLUMWjy5jgHK1NC52DXXrriwihVrYZKqjk&index=16 ➢ https://in.mathworks.com/videos/understanding-control-systems-part-3-components-of-a-feedback-control-system-123645.html ➢ https://ocw.mit.edu/resources/res-6-010-electronic-feedback-systems-spring-2013/course-videos/lecture-5-root-locus/ ➢ https://www.youtube.com/watch?v=WBCZBOB3LCA&index=18&list=PLUMWjy5jgHK1NC52DXXrriwihVrYZKqjk ➢ https://www.youtube.com/watch?v=CRvVDoQJjYI&list=PLUMWjy5jgHK1NC52DXXrriwihVrYZKqjk&index=21 ➢ https://www.youtube.com/watch?v=pG3_b7wuweQ&list=PLUMWjy5jgHK1NC52DXXrriwihVrYZKqjk&index=25			
37-48	TB2, Chapter 11	**Introduction to Digital Control System**: Introduction, Spectrum Analysis of Sampling process, Signal reconstruction, Difference equations. Introduction to State variable analysis: Introduction, Concept of State, State variables & State model, State model for Linear Continuous & Discrete time systems, Diaganolisation.	Chalk and Talk	20
Links to some useful online lectures: ➢ https://in.mathworks.com/videos/state-space-models-part-1-creation-and-analysis-100815.html				
49-60	TB1, Chapter 8,9	**Frequency domain analysis and stability:** Correlation between time and frequency response, Bode Plots, Experimental determination of transfer function. Introduction to Polar Plots, (Inverse Polar Plots excluded) Mathematical preliminaries, Nyquist Stability criterion, Introduction to lead, lag and lead-lag compensating networks	Chalk and Talk Video lectures for some topics	20

Links to some useful online lectures:

- https://www.youtube.com/watch?v=sof3meN96MA&index=26&list=PLUMWjy5jgHK1NC52DXXrriwihVrYZKqjk
- https://ocw.mit.edu/resources/res-6-010-electronic-feedback-systems-spring-2013/course-videos/lecture-7-stability-via-frequency-response/
- https://www.youtube.com/watch?v=FXbKYT1G6Xs&index=35&list=PL692A7B9169289C4F
- https://in.mathworks.com/videos/understanding-bode-plots-why-use-them-1-of-4-76194.html
- https://www.youtube.com/watch?v=Rbvau5oXOkg
-

Text Books	
1.	J.Nagarath and M.Gopal, " Control Systems Engineering", New Age International (P) Limited, Publishers, Fifth edition-2005, ISBN: 81-224-2008-7.
Reference Books	
11.	"Modern Control Engineering," K.Ogata, Pearson Education Asia/PHI, 4th Edition, 2002. ISBN 978-81-203-4010-7.
12.	"Automatic Control Systems", Benjamin C. Kuo, John Wiley India Pvt. Ltd., 8th Edition, 2008.
13.	"Feedback and Control System," Joseph J Distefano III et al., Schaum"s Outlines, TMH, 2nd Edition 2007.

Syllabus for Internal Assessment Tests (IAT)*

IAT #	Syllabus
IAT-1	Class # 01 – 24
IAT-2	Class # 25-48
IAT-3	Class # 48– 60

* See calendar of events for the schedules of IATs.

Course Outcomes
By the end of this course, students will be able to
➢ Develop the mathematical model of mechanical and electrical systems (C403.1)
➢ Understand time domain specifications for first and second order systems (C403.2)
➢ Determine the stability of a system in the time domain using Route Harvitz criteria and root locus technique (C403.3)
➢ Determine the stability of a system in the frequency domain using Nyquist and bode plots (C403.4)
➢ Model a control system in continuous and discrete time using state variable techniques (C403.5)
➢ Develop the mathematical model of mechanical and electrical systems (C403.1)

COGNITIVE LEVELS	
Cognitive level	**REVISED BLOOMS TAXONOMY KEYWORDS**
L1	List, define, tell, describe, identify, show, label, collect, examine, tabulate, quote, name, who, when, where, etc.
L2	summarize, describe, interpret, contrast, predict, associate, distinguish, estimate, differentiate, discuss, extend
L3	Apply, demonstrate, calculate, complete, illustrate, show, solve, examine, modify, relate, change, classify, experiment, discover.
L4	Analyze, separate, order, explain, connect, classify, arrange, divide, compare, select, explain,

	infer.
L5	Assess, decide, rank, grade, test, measure, recommend, convince, select, judge, explain, discriminate, support, conclude, compare, summarize.

PROGRAM OUTCOMES (PO), PROGRAM SPECIFIC OUTCOMES (PSO)	
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.
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.
PSO1	Apply principles of electrical and electronic circuit theory to the design and simulation of analog and digital circuits.

PSO2	Apply principles of mathematics, signal processing and communication theory to analyze different types of signals and to design communication systems.
PSO3	Take part in consultancy projects as an electronics design engineer and documentation and publication of reports.

CORRELATION LEVELS	
0	No Correlation
1	Slight/Low
2	Moderate/ Medium
3	Substantial/ High

Course Outcomes		**Modules covered**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	Know the basic features, configurations and application of control systems.	**1**	3	2	-		-	-	-	-	-	-	-	-	-	-	-	-
CO2	Know various terminologies and definitions for the control systems.	**1,2**	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	Learn how to find a mathematical model of electrical, mechanical and electro-mechanical systems.	**1,5**	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	Know how to find time response from the transfer function.	**2**	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	Find the transfer function via Mason's rule.	**1**	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO6	Analyze the stability of a system from the transfer function.	**3,4**	3	3	-	-	1	-	-	- -	-	-	-	-	-	-	-	-

Note: From time to time, assignments will be posted on

https://sites.google.com/a/cmrit.ac.in/richa-r-tengshe/

CMR Institute of Technology, Bangalore		
Department(s): Telecommunication Engineering		
Semester: 04	Section(s): A	Lectures/week: 05
Subject: Signals & Systems		Code: 15EC44
Course Instructor(s): Mahesh Kumar Jha		
Course duration: 05 Feb. 2018 – 25 May 2018		
Course Site: https://sites.google.com/a/cmrit.ac.in/mahesh-kumar-jha/		

Course Objectives

- Understand the mathematical description of continuous and discrete time signals and systems.
- Analyze the signals in time domain using convolution difference/differential equations.
- Classify signals into different categories based on their properties.
- Analyze Linear Time Invariant (LTI) systems in time and transform domains.
- Build basics for understanding of courses such as signal processing, control system and communication.

Prerequisites

- Complex Numbers
- Euler's identity
- Partial fraction
- Basic Integration and differentiation

Lesson Plan

Lecture #	Book & Sections	Topics	Portions coverage	
			Teaching Aids	% of Syllabus Covered
1-15	TB 1: (1.1, 1.2, 1.4 to 1.8) RB 2: (Chapter-1)	• **Introduction and Classification of signals**: Definition of signal and systems, communication and control systems as examples. Sampling of analog signals, Continuous time and discrete time signal, Classification of signals as even, odd, periodic and non-periodic, deterministic and non-deterministic, energy and power. • **Elementary signals/Functions**: exponential, sine, impulse, step and its properties, ramp, rectangular, triangular, signum, sinc functions. • **Operations on signals**: Amplitude scaling, addition, multiplication, differentiation, integration (Accumulator for DT), time scaling, time shifting and time folding. • **Systems:** DefinitionClassification: linear and nonlinear, time variant and invariant, causal and noncausal, static and dynamic, stable and unstable, invertible.	Chalk and Talk Video Lectures for some topics	10

Links to some useful online lectures:

- https://www.youtube.com/watch?v=IgWHaibHw24
- https://www.youtube.com/watch?v=hFWh0qk5lIk

➢ https://www.youtube.com/watch?v=s8rsR_TStaA&list=PLBlnK6fEyqRhG6s3jYIU48CqsT5cyiDTO ➢ https://www.youtube.com/watch?v=H4hk6N5vC1Q&index=2&list=PLBlnK6fEyqRhG6s3jYIU48CqsT5cyiDTO				
16-31	TB 1: (2.1, 2.2) RB 2 :(2.1, 2.2)	**Time domain representation of LTI System**: System modeling: Input-output relation, definition of impulse response, convolution sum, convolution integral,computation of convolution integral and convolution sum using graphical method for unit step to unit step, unit step to exponential, exponential to exponential, unit step to rectangular and rectangular to rectangular only. Properties of convolution.	Chalk and Talk Video Lectures for some topics	10
Links to some useful online lectures: ➢ https://www.youtube.com/watch?v=U3BwStzKvs0 ➢ https://www.youtube.com/watch?v=_HATc2zAhcY&t=977s ➢ https://www.youtube.com/watch?v=SNdNf3mprrU ➢ https://www.youtube.com/watch?v=Ma0YONjMZLI ➢ https://www.youtube.com/watch?v=r18Gi8lSkfM&t=550s				
31-41	TB 1: (3.1, 3.2, 3.3, 3.6) RB 2:(3.1 to 3.8)	System interconnection, system properties in terms of impulse response, step response in terms of impulse response. **Fourier Representation of Periodic Signals**:Introduction to CTFS and DTFS, definition, properties	Chalk and Talk	10
Links to some useful online lectures: ➢ http://demonstrations.wolfram.com/FourierSeriesCoefficientsOfARectangularPulseSignal/ ➢ https://www.youtube.com/watch?v=dhNciO_TwnA ➢ https://www.youtube.com/watch?v=SWt2PYiGgKQ ➢ https://www.youtube.com/watch?v=I-LLImQTIPw ➢ https://www.youtube.com/watch?v=blS_OImUJ-c&index=143&list=PLBlnK6fEyqRhG6s3jYIU48CqsT5cyiDTO ➢ https://www.youtube.com/watch?v=oXrbcRyXj84&list=PLBlnK6fEyqRhG6s3jYIU48CqsT5cyiDTO&index=150				
42-57	TB 1: (3.4, 3.5, 3.6, 4.1, 4.2, 4.3, 4.5, 4.6) RB 1: (4.1, 4.2, 4.3, 4.4, 5.1, 5.2, 5.3, 5.4)	• **Fourier Representation of aperiodic Signals: FT representation of aperiodic CT signals** - FT, definition, FT of standard CT signals, Properties and their significance. • **FT representation of aperiodic discrete signals-DTFT**, definition, DTFT of standard discrete signals, Properties and their significance. • **Impulse sampling and reconstruction**: Sampling theorem (only statement) and reconstruction of signals.	Chalk and Talk Video Lectures for some topics	10
58-66	TB 1: (7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 7.8) RB 1: (10.1-10.3,10.5, 10.7,10.8,	**Z-Transforms**: Introduction, the Z-transform, properties of the Region of convergence, Properties of the Z-Transform, Inversion of the Z-Transform, Transform analysis of LTI systems.	Chalk and Talk Video Lectures for some topics	10

	10.9)			

Links to some useful online lectures:

- https://www.youtube.com/watch?v=4ZYlHTcdB8Q
- https://www.youtube.com/watch?v=RprzYUDKrrA
- https://www.youtube.com/watch?v=lL3pp7MP3Xc

Text Books	
1.	Simon Haykins and Barry Van Veen, "Signals and Systems", 2nd Edition,2008, Wiley India. ISBN 9971-51-239-4.
Reference Books	
14.	Michael Roberts, "Fundamentals of Signals & Systems", 2nd edition,Tata McGraw-Hill, 2010, ISBN 978-0-07-070221-9.
15.	Alan V Oppenheim, Alan S, Willsky and A Hamid Nawab, "Signals andSystems" Pearson Education Asia / PHI, 2nd edition, 1997. Indian Reprint 2002.
16.	H. P Hsu, R. Ranjan, "Signals and Systems", Scham's outlines, TMH,2006.
17.	B. P. Lathi, "Linear Systems and Signals", Oxford University Press, 2005.
18.	Ganesh Rao and Satish Tunga, "Signals andSystems",Pearson/Sanguine Technical Publishers, 2004.

Syllabus for Internal Assessment Tests (IAT*)

IAT #	Syllabus
IAT-1	Class # 01 – 24
IAT-2	Class # 25–50
IAT-3	Class # 51–66

*See calendar of events for IAT schedule.

Course Outcomes
By the end of this course, students will be able to
1. Understand mathematical description and representation of continuous and discrete time signals and systems.
2. Develop input output relationship for linear shift invariant system and understand the convolution operator for continuous and discrete time system.
3. Understand and resolve the signals in frequency domain using Fourier series and Fourier transforms.
4. Understand the limitations of Fourier transform and need for Laplace transform and develop the ability to analyze the system in s- domain.
5. Understand the basic concept of Z transform and to develop the ability to analyze systems in Z-domain.

**Based on table 01, 02, 03 in appendix, following are the Course outcomes.

Course Outcomes		Modules covered	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Understand mathematical description and representation of continuous anddiscrete time signals and systems.	**1**	3	2	2	-	-	-	-	-	-	-	-	-	-	2	-
CO2	Develop input output relationship for linear shift invariant system andunderstand the convolution operator for continuous and discrete time system.	**2**	3	2	2	-	-	-	-	-	-	-	-	-	-	2	-

CO3	Understand and resolve the signals in frequency domain using Fourier series andFourier transforms	**3**	3	2	2	-	-	-	-	-	-	-	-	-	-	2	-
CO4	Understand the limitations of Fourier transform and need for Laplace transformand develop the ability to analyze the system in s- domain	**4**	3	2	2	-	-	-	-	-	-	-	-	-	-	2	-
CO5	Understand the basic concept of Z transform and to develop the ability to analyze systems in Z- domain	**5**	3	2	2	-	-	-	-	-	-	-	-	-	-	2	-

Note: Assignments, study material, Question bank and other course related content would be posted on site mentioned above.

Signature with date:	**Course Instructor**	**Program Coordinator**	**Head-TCE**

Appendix

Table 01: Cognitive Levels

Cognitive Levels	
Cognitive level	**Revised Blooms Taxonomy Keywords**
L1	List, define, tell, describe, identify, show, label, collect, examine, tabulate, quote, name, who, when, where, etc.
L2	summarize, describe, interpret, contrast, predict, associate, distinguish, estimate, differentiate, discuss, extend
L3	Apply, demonstrate, calculate, complete, illustrate, show, solve, examine, modify, relate, change, classify, experiment, discover.
L4	Analyze, separate, order, explain, connect, classify, arrange, divide, compare, select, explain, infer.
L5	Assess, decide, rank, grade, test, measure, recommend, convince, select, judge, explain, discriminate, support, conclude, compare, summarize.

Table 02: Program Outcomes (PO) and Program Specific Outcomes (PSO)

Program Outcomes (PO), Program Specific Outcomes (PSO)	
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 modelling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1	Apply principles of electrical and electronic circuit theory to the design and simulation of analog and digital circuits.
PSO2	Apply principles of mathematics, signal processing and communication theory to analyze different types of signals and to design communication systems.
PSO3	Take part in consultancy projects as an electronics design engineer and documentation and publication of reports.

Table 03: Correlation Levels

Correlation Levels	
0	No Correlation
1	Slight/Low
2	Moderate/ Medium
3	Substantial/ High

CMR Institute of Technology, Bangalore		
Department(s): Tele communication Engineering		
Semester: 04	Section(s): A	Lectures/week: 04
Subject: System Modelling & Simulation		Code: 15EC45
Course Instructor(s): Reshma P G		
Course duration: 01 Feb 2018 – 25 May 2018		
Course Site: https://sites.google.com/a/cmrit.ac.in/https-sites-google-com-reshmapg-cmrit-ac-in/		

Course Objectives

- Design simple systems for generating and demodulating AM, DSB, SSB and VSB signals
- Understand the concepts in Angle modulation for the design of communication Systems
- Design simple systems for generating and demodulating frequency modulated Signals
- Learn the concepts of random process and various types of noise
- Evaluate the performance of the communication system in presence of noise
- Analyze pulse modulation and sampling techniques

Prerequisites

- Basics of signals and systems
- Fourier Transform
- Trigonometric equations

Lesson Plan

Lecture #	Book & Sections	Topics	Portions coverage	
			Teaching Aids	% of Syllabus Covered
1-10	TB1: - 3.1- 3.8	**MODULE I**: AMPLITUDE MODULATION: Introduction, Amplitude Modulation: Time & Frequency – Domain description, Switching modulator, Envelop detector. DOUBLE SIDE BAND-SUPPRESSED CARRIER MODULATION: Time and Frequency – Domain description, Ring modulator, Coherent detection, Costas Receiver, Quadrature Carrier Multiplexing. SINGLE SIDE–BAND AND VESTIGIAL SIDEBAND METHODS OF MODULATION: SSB Modulation, VSB Modulation, Frequency Translation, Frequency- Division Multiplexing, Theme Example: VSB Transmission of Analog and Digital Television	Chalk and Talk Video Lectures for some topics	20

Links to some useful online lectures:

- https://www.youtube.com/watch?v=CRXxm8N7oKU
- https://www.youtube.com/watch?v=fGf_ng7qljI
- https://www.youtube.com/watch?v=NTcDup0_B4w&list=PL7748E9BEC4ED83CA&index=7
- https://www.youtube.com/watch?v=xn6lzrMJUDs

11-20	TB1 4.1- 4.6	**MODULE II**: ANGLE MODULATION: Basic definitions, Frequency Modulation: Narrow Band FM, Wide Band FM, Transmission bandwidth of FM Signals, Generation of FM Signals, Demodulation of FM Signals, FM Stereo Multiplexing, Phase–Locked Loop: Nonlinear model of PLL, Linear model of PLL, Nonlinear Effects in FM Systems. The Superheterodyne Receiver	Chalk and Talk Video Lectures for some topics	20
Links to some useful online lectures: ➢ https://www.youtube.com/watch?v=QEubAxBfqKU ➢ https://www.youtube.com/watch?v=x9hnbzF9XC8 ➢ https://www.youtube.com/watch?v=xn6lzrMJUDs				
20-30	TB1 5.1 - 5.6, 5.10, 6.7	**MODULE III**: RANDOM VARIABLES & PROCESS: Introduction, Probability, Conditional Probability, Random variables, Several Random Variables. Statistical Averages: Function of a random variable, Moments, Random Processes, Mean, Correlation and Covariance function: Properties of autocorrelation function, Cross–correlation functions NOISE: Shot Noise, Thermal noise, White Noise, Noise Equivalent Bandwidth , Noise Figure	Chalk and Talk	20
Links to some useful online lectures: ➢ https://www.youtube.com/watch?v=rifK8BtHaYI ➢ https://www.youtube.com/watch?v=dSej7AHlim4				
30-40	TB1 6.1-6.6	**MODULE IV**: NOISE IN ANALOG MODULATION: Introduction, Receiver Model, Noise in DSB-SC receivers, Noise in AM receivers, Threshold effect, Noise in FM receivers, Capture effect, FM threshold effect, FM threshold reduction, Pre-emphasis and De-emphasis in FM	Chalk and Talk Video Lectures for some topics	20
Links to some useful online lectures: ➢ https://www.youtube.com/watch?v=WT1Y97riAQQ				
40-50	TB1 7.1-7.6, REF1: 6.8	**MODULE V**: DIGITAL REPRESENTATION OF ANALOG SIGNALS: Introduction, Why Digitize Analog Sources?, The Sampling process, Pulse Amplitude Modulation, Time Division Multiplexing, Pulse-Position Modulation, Generation of PPM Waves, Detection of PPM Waves, The Quantization Process, Quantization Noise, Pulse– Code Modulation: Sampling, Quantization, Encoding, Regeneration, Decoding, Filtering, Multiplexing, Application to Vocoder .	Chalk and Talk Video Lectures for some topics	20
Links to some useful online lectures: ➢ https://www.youtube.com/watch?v=xfxQ-zBp2OQ ➢ https://www.youtube.com/watch?v=yWqrx08UeUs				

Text Books	
1.	Communication Systems, Simon Haykins & Moher, 5th Edition, John Willey, India Pvt. Ltd, 2010, ISBN 978 – 81 – 265 – 2151 – 7.

Reference Books	
19.	Modern Digital and Analog Communication Systems, B. P. Lathi, Oxford University Press., 4th edition.
20.	An Introduction to Analog and Digital Communication, Simon Haykins, John Wiley India Pvt. Ltd., 2008, ISBN 978–81–265–3653–5.
21.	Principles of Communication Systems, H.Taub & D.L.Schilling, TMH, 2011.
22.	Communication Systems, Harold P.E, Stern Samy and A Mahmond, Pearson Edition, 2004.
23.	Communication Systems: Analog and Digital, R.P.Singh and S.Sapre: TMH 2nd edition, 2007.

Syllabus for Internal Assessment Tests (IAT*)

IAT #	Syllabus
IAT-1	Class # 01 – 20
IAT-2	Class # 21–36
IAT-3	Class # 37–50

*See calendar of events for IAT schedule.

Course Outcomes
By the end of this course, students will be able to
➢ Determine the performance of analog modulation schemes in time and frequency domains..
➢ Determine the performance of systems for generation and detection of modulated analog signals
➢ Characterize analog signals in time domain as random processes and in frequency domain using Fourier transforms.
➢ Characterize the influence of channel on analog modulated signals
➢ Determine the performance of analog communication systems.
➢ Understand the characteristics of pulse amplitude modulation, pulse position modulation and pulse code modulation systems.

**Based on table 01, 02, 03 in appendix, following are the Course outcomes.

Course Outcomes		Modules covered	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Determine the performance of analog modulation schemes in time and frequency domains	1,2	3	3	-	3	3	-	-	-	3	-	-	2	-	3	-
CO2	Determine the performance of systems for generation and detection of modulated analog signals	1,2	3	3	-	3	3	-	-	-	3	-	-	2	-	3	-
CO3	Characterize analog signals in time domain as random processes and in frequency domain using Fourier transforms.	3	3	3	-	-	2	-	-	-	-	-	-	1	-	-	-
CO4	Characterize the influence of channel on analog modulated signals	4	3	3	-	-	3	-	-	-	-	-	-	2	-	2	-
CO5	Determine the performance of analog communication systems	4	3	3	-	-	-	-	-	-	2	-	-	2	-	2	-
CO6	Understand the characteristics of pulse amplitude modulation, pulse position modulation and pulse code	5	2		-	3	3	-	-	-	3	-	-	1	-	2	-

	modulation systems																

Note: Assignments, study material, Question bank and other course related content would be posted on site mentioned above.

Signature with date:	**Course Instructor**	**Program Coordinator**	**Head-CSE**

Appendix

Table 01: Cognitive Levels

Cognitive Levels	
Cognitive level	**Revised Blooms Taxonomy Keywords**
L1	List, define, tell, describe, identify, show, label, collect, examine, tabulate, quote, name, who, when, where, etc.
L2	summarize, describe, interpret, contrast, predict, associate, distinguish, estimate, differentiate, discuss, extend
L3	Apply, demonstrate, calculate, complete, illustrate, show, solve, examine, modify, relate, change, classify, experiment, discover.
L4	Analyze, separate, order, explain, connect, classify, arrange, divide, compare, select, explain, infer.
L5	Assess, decide, rank, grade, test, measure, recommend, convince, select, judge, explain, discriminate, support, conclude, compare, summarize.

Table 02: Program Outcomes (PO) and Program Specific Outcomes (PSO)

Program Outcomes (PO), Program Specific Outcomes (PSO)	
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 modelling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1	Apply principles of electrical and electronic circuit theory to the design and simulation of analog and digital circuits.
PSO2	Apply principles of mathematics, signal processing and communication theory to analyze different types of signals and to design communication systems.
PSO3	Take part in consultancy projects as an electronics design engineer and documentation and publication of reports.

Table 03: Correlation Levels

Correlation Levels	
0	No Correlation
1	Slight/Low
2	Moderate/ Medium
3	Substantial/ High

CMR Institute of Technology, Bangalore		
Department(s): Telecommunication Engineering		
Semester: 04	Section(s): A	Lectures/week: 04
Subject: LINEAR INTEGRATED CIRCUITS		Code: 15EC46
Course Instructor(s): Anindita Sahoo		
Course duration: 05 Feb 2018 – 25 May 2018		
Course Site: https://sites.google.com/a/cmrit.ac.in/anindita-s/home?pli=1		

Course Objectives

This course will enable students to:

- Define the basic concepts of OP-Amp.
- Define and describe various parameters of Op-Amp, its characteristics and specifications.
- Discuss the effects of Input and Output voltage ranges upon Op-Amp circuits.
- Sketch and Analyze Op-Amp circuits to determine Input Impedances, output Impedances and other performance parameters.
- Sketch and Explain typical Frequency Response graphs for each of the Filter circuits showing Butterworth and Chebyshev responses where ever appropriate.
- Describe and Sketch the various switching circuits of Op-Amps and analyze its operations.
- Differentiate between various types of DACs and ADCs and evaluate the performance of each with neat circuit diagrams and assuming suitable inputs.

Prerequisites

- Kirchhoff's current law, Kirchhoff's voltage law
- voltage divider rule, Current divider rule
- Feedback Concepts

Lesson Plan

Lecture #	Book & Sections	Topics	Portions coverage: Teaching Aids	Portions coverage: % of Syllabus Covered
1-3	TB1, Chapter 1,2	**Operational Amplifier Fundamentals:** Basic Op-amp circuit, Op-Amp parameters – Input and output voltage, CMRR and PSRR,	Chalk and Talk Video Lectures for some topics	5%
Links to some useful online lectures: https://www.youtube.com/watch?v=Di_Occf4Z2k https://www.youtube.com/watch?v=mlW3nMnb8JU https://www.youtube.com/watch?v=R7z8YlT8aYU https://www.youtube.com/watch?v=U3BGOaiyjz8				
4-6	TB1, Chapter 2		Chalk and Talk	5%

		Offset voltages and currents, Input and output impedances, Slew rate and Frequency limitations.	Video Lectures for some topics	
Links to some useful online lectures: ➢ https://www.youtube.com/watch?v=XStk6D6XYZ0 ➢ https://www.youtube.com/watch?v=TfNzO5wfRDc ➢ https://www.youtube.com/watch?v=clTA0pONnMs&t=2593s ➢ https://www.youtube.com/watch?v=lJDjWZqhpVc				
7-11	TB1, Chapter3	**OP-Amps as DC Amplifiers** – Biasing OP-amps, Direct coupled voltage followers, Non-inverting amplifiers, inverting amplifiers, Summing amplifiers, and Difference amplifiers. Interpretation of OP-amp LM741 & TL081 datasheet.	Chalk and Talk	10%
Links to some useful online lectures: ➢ https://www.youtube.com/watch?v=_Ut-nQ535iE ➢ https://www.youtube.com/watch?v=U1KbM4ffiLg ➢ https://www.khanacademy.org/science/electrical-engineering/ee-amplifiers/modal/v/ee-summing-opamp ➢ https://www.khanacademy.org/science/electrical-engineering/ee-amplifiers/modal/v/ee-virtual-ground ➢ https://www.khanacademy.org/science/electrical-engineering/ee-amplifiers/modal/v/ee-feedback				
12-17	TB1, Chapter4	**Op-Amps as AC Amplifiers:** Capacitor coupled voltage follower, High input impedance – Capacitor coupled voltage follower, Capacitor coupled non inverting amplifiers, High input impedance – Capacitor coupled Non inverting amplifiers, Capacitor coupled inverting amplifiers, setting the upper cut-off frequency, Capacitor coupled difference amplifier.	Chalk and Talk Video Lectures for some topics	12%
Links to some useful online lectures: ➢ https://www.youtube.com/watch?v=egCiRSasxpw				
18-21	TB1, Chapter 6	**OP-amp Applications:** Voltage sources, current sources and current sinks, current amplifiers, instrumentation amplifier, precision rectifiers.	Chalk and Talk	8%
Links to some useful online lectures: ➢ https://www.youtube.com/watch?v=dCojRDwoFaI ➢ https://www.youtube.com/watch?v=hHAjk3KDHnk ➢ https://www.youtube.com/watch?v=dYKY6n201sk&t=117s				
22-29	TB1, Chapter 7	**More Applications :** Limiting circuits, Clamping circuits, Peak detectors, Sample and hold circuits, V to I and I to V converters, Differentiating Circuit, Integrator Circuit, Phase shift oscillator, Wein bridge oscillator, Crossing detectors**,** inverting Schmitt trigger.	Chalk and Talk	15%
Links to some useful online lectures: ➢ http://nptel.ac.in/courses/117107094/13 ➢ http://nptel.ac.in/courses/117107094/21 ➢ https://ocw.mit.edu/resources/res-6-010-electronic-feedback-systems-spring-2013/course-videos/lecture-18-oscillators-intentional/ ➢ https://www.youtube.com/watch?v=97Hn0TYqj7E ➢ https://ocw.mit.edu/resources/res-6-010-electronic-feedback-systems-spring-2013/course-videos/lecture-13-operational-amplifier-compensation-cont./				

30-32	TB2, Chapter 4	Log and antilog amplifiers, Multiplier and divider.	Chalk and Talk	5%
Links to some useful online lectures: ➢ https://www.youtube.com/watch?v=YpZ1GFUYxLk				
33-42	TB1, Chapter 11 TB2, Chapter 6	**Active Filters:** First order and second order active Low-pass and high pass filters, Bandpass Filter, Bandstop Filter. **Voltage Regulators:** Introduction, Series Op-amp regulator, IC voltage regulators. 723 general purpose regulators.	Chalk and Talk	20%
Links to some useful online lectures: ➢ https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-002-circuits-and-electronics-spring-2007/video-lectures/lecture-18/				
43-52	TB2, Chapter 8,9	**Phase locked loop:** Basic Principles, Phase detector/comparator, VCO. **DAC and ADC convertor**: DAC using R-2R, ADC using Successive approximation. **Other IC Application:** 555 timer, Basic timer circuit, 555 timer used as astable and monostablemultivibrator.	Chalk and Talk	20%
Links to some useful online lectures: ➢ https://www.electronics-tutorials.ws/waveforms/555_oscillator.html ➢ https://www.electronics-tutorials.ws/waveforms/555_timer.html ➢ https://www.youtube.com/watch?v=Izs-1z-LekE ➢ https://www.youtube.com/watch?v=bXUfDLF4MVc				

Text Books	
1.	Operational Amplifiers and Linear IC's, David A. Bell, 2nd edition, PHI/Pearson, 2004. ISBN 978-81-203-2359-9.
2.	Linear Integrated Circuits, D. Roy Choudhury and Shail B. Jain, 4nd edition, Reprint 2006, New Age International ISBN 978-81-224-3098-1.

Syllabus for Internal Assessment Tests (IAT*)

IAT #	Syllabus
IAT-1	Class # 01 – 18
IAT-2	Class # 19–37
IAT-3	Class # 38–52

*See calendar of events for IAT schedule.

Course Outcomes
By the end of this course, students will be able to
6. Explain the basic principles, configurations and practical limitations of op-amp. (C406.1)
7. Explain the various linear and non-linear applications of op-amp. (C406.2)
8. Explain the operation of most commonly used D/A and A/D converter types and its applications. (C406.3)
9. Design op-amp oscillators, single chip oscillators and frequency generators. (C406.4)
10. Design active filters given frequency response characteristics. (C406.5)
11. Design IC based linear voltage regulator and explain the switched mode supply operation. (C406.6)

**Based on table 01, 02, 03 in appendix, following are the Course outcomes.

Course Outcomes		Modules covered	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	Explain the basic principles, configurations and practical limitations of op-amp.	**1**	2	2	1	1	-	1	-	-	-	-	-	1	1	-	1	-
CO2	Explain the various linear and non-linear applications of op-amp.	**2**	2	3	-	1	-	1	2	1	2	-	-	2	1	-	1	-
CO3	Explain the operation of most commonly used D/A and A/D converter types and its applications.	**5**	2	3	2	2	2	2	1	-	1	-	-	1	1	-	1	-
CO4	Design op-amp oscillators, single chip oscillators and frequency generators.	**3**	1	2	1	-	2	1	-	-	-	-	-	1	1	-	1	-
CO5	Design active filters given frequency response characteristics.	**4**	2	2	-	-	2	-	-	-	-	-	-	2	1	-	1	-
CO6	Design IC based linear voltage regulator and explain the switched mode supply operation	**4**	-	-	-	-	1	-	-	- -	-	-	-	-	1		1	

Note: Assignments, study material, Question bank and other course related content would be posted on site mentioned above.

Signature with date:	**Course Instructor**	**Program Coordinator**	**Head-CSE**

Appendix

Table 01: Cognitive Levels

Cognitive Levels	
Cognitive level	**Revised Blooms Taxonomy Keywords**
L1	List, define, tell, describe, identify, show, label, collect, examine, tabulate, quote, name, who, when, where, etc.
L2	summarize, describe, interpret, contrast, predict, associate, distinguish, estimate, differentiate, discuss, extend
L3	Apply, demonstrate, calculate, complete, illustrate, show, solve, examine, modify, relate, change, classify, experiment, discover.
L4	Analyze, separate, order, explain, connect, classify, arrange, divide, compare, select, explain, infer.
L5	Assess, decide, rank, grade, test, measure, recommend, convince, select, judge, explain, discriminate, support, conclude, compare, summarize.

Table 02: Program Outcomes (PO) and Program Specific Outcomes (PSO)

Program Outcomes (PO), Program Specific Outcomes (PSO)	
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 modelling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1	Design, implement and maintain business applications in a variety of languages using libraries and frameworks.
PSO2	Develop and simulate wired and wireless network protocols for various network applications using modern tools.
PSO3	Apply the knowledge of software and design of hardware to develop embedded systems for real world applications.
PSO4	Apply knowledge of web programming and design to develop web based applications using database and other technologies

Table 03: Correlation Levels

Correlation Levels	
0	No Correlation
1	Slight/Low
2	Moderate/ Medium
3	Substantial/ High