# INSTITUTE OF AERONAUTICAL ENGINEERING

**(Autonomous)**

Dundigal, Hyderabad - 500 043

**ELECTRONICS AND COMMUNICATION ENGINEERING**

## COURSE DESCRIPTION FORM

| | | | | |
|---|---|---|---|---|
| **Course Title** | **LINEAR AND DIGITAL INTEGRATED CIRCUITS APPLICATIONS** | | | |
| **Course Code** | **R15-A50425** | | | |
| **Regulation** | **R15 – JNTUH** | | | |
| **Course Structure** | Lectures | Tutorials | Practicals | Credits |
| | 4 | - | - | 4 |
| **Course Coordinator** | Mr. D. Khalandar Basha, Associate professor, ECE | | | |
| **Team of Instructors** | Ms.G.Manisha, Mr. B. Naresh, Ms. P.Saritha, Associate Professor, ECE | | | |

## I. COURSE OVERVIEW

Integrated Circuits design can be divided into the broad categories of digital and analog IC design. The physical world is inherently analog indicating that there is always need for analog circuitry. Today the growth of any industry is dependent upon electronics to a great extent. Integrated circuit is electronics and this course IC application acquaints the students with general analog principles and design methodologies using practical devices and applications. It focus on process of learning about signal condition, signal generation, instrumentation, timing and control using various IC circuitry. With modern digitization advantages we need to work with digital data and hence digital ICs play a crucial role in connecting physical world to the more sophisticated digital world. This course focuses on analysis, design and applications of modern digital integrated circuits.

## II. PREREQUISITE(S)

| Level | Credits | Periods/ Week | Prerequisites |
|---|---|---|---|
| UG | 4 | 4 | EDC, PDC |

## III. MARKS DISTRIBUTION

| Sessional Marks (25 Marks) | University End Marks | Total Marks |
|---|---|---|
| **Mid Semester Test**<br>There shall be 2 midterm examinations. Each midterm examination consists of subjective type and Objective type tests. The subjective test is for 10 marks, with duration of 1 hour. Subjective test of each semester shall contain 4 questions The student has to answer 2 questions, each carrying 5 marks. The objective type test is for 10 marks with duration of 20minutes. It consists of 10 Multiple choice and 10 objective type questions. The student has to answer all the questions and each carries half mark. First midterm examination shall be conducted for the first 21/2 unit of syllabus and second midterm examination shall be conducted for the remaining portion.<br>Five marks are earmarked for assignments.<br>There shall be two assignments in every theory course. Marks shall be awarded considering the average of two assignments in each course reason whatsoever, will get zero marks(s).the conduct of the second mid-examination. The total marks secured by the student in each mid-term examination are evaluated for 25 marks, and the average of the two mid-term examinations shall be taken as the final marks secured by each candidate. | 75 | 100 |

## IV. EVALUATION SCHEME

| S. No | Component | Duration | Marks |
|---|---|---|---|
| 1. | I Mid Examination | 80 minutes | 20 |
| 2. | I Assignment | - | 5 |
| 3. | II Mid Examination | 80 minutes | 20 |
| 4. | II Assignment | - | 5 |
| 5. | External Examination | 3 hours | 75 |

## V. COURSE OBJECTIVES

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

1. To understand the internal block diagram of operational amplifier and its characteristics both ideal and practical.
2. To illustrate some typical applications of operational amplifiers in linear and non linear modes of operation.
3. To construct various active filter circuits using operational amplifier for various frequency response characteristics.
4. To study the block diagrams of 555 timer and 565 phase locked loops ICs and use them to construct various applications.
5. To study the techniques of Analog to digital and digital to analog converters and its specifications
6. To differentiate between CMOS and TTL logic families, realize various logic functions using CMOS logic and study various combinational and sequential circuits using TTL logic.

## VI. COURSE OUTCOMES

**After completing this course the student must demonstrate the knowledge and ability to**

1. Understand the internal operation of Op-Amp and its specifications.
2. Analyze and design linear applications like adder, subs tractor, instrumentation amplifier and etc. using Op-Amp.
3. Analyze and design non linear applications like multiplier, comparator and etc, using Op-Amp.
4. Classify various active filter configurations based on frequency response and construct using 741 Op-Amp.
5. Operate 555 timers in different modes like bistable, monostable and astable operations and study their applications.
6. Determine the lock range and capture range of PLL and use in various applications of communications.
7. Differentiate between fixed and variable voltage regulator ICs and also A to D and D to A conversion techniques.
8. Understand the conversion process of ADC and DAC in digital electronics
9. Explain the differences between CMOS and TTL logic families and study various digital ICs.
10. Design input/output interfacing with CMOS integrated circuits.
11. Design TTL/CMOS combinational circuits.
12. Design TTL/CMOS sequential circuits.
13. Understand and design memories.

## VII. HOW PROGRAM OUTCOMES ARE ASSESSED

| Program Outcomes | | Level | Proficiency assessed by |
|---|---|---|---|
| PO1 | **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems. | S | Assignments, Exercises |
| 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. | S | Hands on Practice Sessions |
| 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. | S | Lab Sessions |
| 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. | S | -- |
| 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. | S | Design Exercises |
| 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. | N | -- |
| 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. | N | -- |
| PO8 | **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice. | N | -- |
| PO9 | **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. | N | Seminars Discussions |
| 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. | N | -- |
| 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. | N | Design Exercises, Seminars, Paper Presentations |
| 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. | S | Design Exercises, Development of Prototypes. |

**N - None** **S - Supportive** **H - Highly Related**

## VIII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED

| Program Specific Outcomes | | Level | Proficiency assessed by |
|---|---|---|---|
| PSO1 | **Professional Skills:** Able to utilize the knowledge of high voltage engineering in collaboration with power systems in innovative, dynamic and challenging environment, for the research based team work.. | S | Lectures, Assignments |
| PSO2 | **Problem-Solving Skills:** Can explore the scientific theories, ideas, methodologies and the new cutting edge technologies in renewable energy engineering, and use this erudition in their professional development and gain sufficient competence to solve the current and future energy problems universally. | S | Projects |
| PSO3 | **Successful Career and Entrepreneurship:** The understanding of technologies like PLC, PMC, process controllers, transducers and HMI one can analyze, design electrical and electronics principles to install, test , maintain power system and applications.. | S | Guest Lectures |

**N - None** **S - Supportive** **H - Highly Related**

## IX. SYLLABUS

**UNIT –I OPERATIONAL AMPLIFIER:** Ideal and Practical Operational amplifier,Op-Amp characteristics - DC and AC. features of Op-Amp IC741 Op-Amp, Inverting and non-inverting amplifiers, Differential, Instrumentation amplifier, AC amplifier, Integrator and differentiator, Comparators, Schmitt trigger, IC Voltage Regulators, IC 723 general purpose regulators, Three Terminal Voltage Regulators.

**UNIT-II OP-AMP, IC -555 & IC 565 Applications:** Introduction to Active Filters characteristics, Butterworth filters – 1st order low pass and high pass filters, band pass, band reject and all pass filters. Triangular and Square waveform generators, Introduction to IC 555 timer, description of functional diagram, monostable and Astable operations and applications, PLL - introduction, basic principle, phase detector/comparator, Voltage Controlled Oscillator (IC 566), low pass filter, monolithic PLL and applications of PLL.

**UNIT-III DATA CONVERTERS:** Introduction, basic DAC techniques - weighted resistor DAC, R-2R ladder DAC, inverted R-2RDAC, A to D converters - parallel comparator type ADC, counter type ADC, successive approximation ADC and dual slope ADC, DAC and ADC Specifications.

**UNIT-IV DIGITAL INTERAGETED CIRCUITS:** Classification of IC's, Comparison of various logic families, CMOS Transmission Gate, IC Interfacing –TTL Driving CMOS & cmos Driving TTL, Combinational Logic ICs Specifications and Applications of TTL-74XX & CMOS 40XX Series IC's Code Converters, Decoders, Demultiplexers, LED &LCD Decoders with Drivers, Encoders, Priority Encoders, Priority Encoders Multiplexers, Demultiplexers, Priority Generators/Checkers, Parallel Binary Adder/Subtractor, Magnitude Comparators.

**UNIT-V SEQUNTIAL LOGIC ICS AND MEMORIES:** Familiarity with commonly available 74XX & CMOS 40XX series ICs-Flip Flops (IC 7474, IC 7473), Shift Registers, Universal Shift Register(IC 74194), Synchronous counters, Decade Counters, Shift Registers.
Memories – ROM Architecture, Types of ROMS & applications, RAM Architecture, Static and Dynamic RAMs.

**TEXT BOOKS:**
1. Digital Design, Morris Mano, 4th Edition
2. Linear Integrated Circuit, D. Roy Choudhury 4th edition, New Age International Pvt. Ltd.
3. Op-Amps & Linear ICs, Ramakanth A, Gayakwad , PHI

**REFERENCE BOOKS:**
1. Op-Amps & Linear ICs, Ramakanth A, Gayakwad , PHI

2. Operational Amplifiers& linear integrated circuits, R.F. Coughlin & Fredrick F. Driscoll, PHI.
3. Operational Amplifiers& linear integrated circuits: Theory & Applications, Denton J. Daibey,TMH
4. Sergio Franco (1997), Design with Operational Amplifiers and Analog Integrated Circuits, McGraw Hill, New Delhi.
5. Digital Fundamentals- Floyd and Jain, Pearson Education.

## IX. COURSE PLAN

**At the end of the course, the students are able to achieve the following course learning outcomes**

| Lecture No. | Unit | Course Learning Objectives | Topics to be covered | Reference |
|---|---|---|---|---|
| 1 | I | To Know the basics of IC's and Classification of IC's | Introduction, Classification of IC's, | T1 |
| 2 | | To Know the sizes of IC's based on the number of Gates and Transistors | IC chip size and circuit complexity, | T1 |
| 3 | | To Know the Basics of Linear IC OP-AMP and its features | Basic information of Op-Amp IC741 Op-Amp and its features | T1 |
| 4-6 | | To understand the operation of OP-AMP's | The ideal & practical Operational amplifier | T1 |
| 7-8 | | To Study the Block diagram of OP-AMP | Op-Amp Block diagram , | T1 |
| 9 | | To understand the DC characteristics of OP-AMP's | Op-Amp characteristics - DC | T1 |
| 10 | | T0 understand the AC characteristics of OP-AMP's | Op-Amp characteristics - AC | T1 |
| 11-12 | | To Understand the Negative feedback of Op-Amp's , To study the Inverting amplifier and practical inverting amplifier circuit | Inverting Amplifiers | T1 |
| 13-14 | | To design the Non Inverting amplifier and practical Non inverting amplifier circuit | Non-inverting Amplifier | T1 |
| 15 | | To design the differential amplifier | Differential amplifier | T1 |
| 16 | | To design the Operation of Instrumentation Amplifier | Instrumentation amplifier | T1 |
| 17 | | To design the operation of AC amplifier | AC amplifier | T1 |
| 18-20 | | To design integrator, differentiator using op-amp | Integrator and differentiator | T1 |
| 21 | | To design regenerative comparator | Schmitt trigger | T1 |
| 22-23 | | To understand the operation of voltage regulators, features | Voltage regulators,723 regulator,3terminal regulators | T1 |
| 24-25 | II | To understand the Operation of First order Butterworth low pass filter and their frequency response | ACTIVE FILTERS: Introduction, Butterworth filters – 1st order low pass filters | T1 |
| 26 | | To understand the Operation of First order Butterworth High pass filter and their frequency response | 1st order high pass filters | T1 |

| | | | | |
|---|---|---|---|---|
| 27 | II | To design the operation and frequency response of Band pass, Band reject and all pass filters. | Band pass, Band reject and All-pass filters. | T1 |
| 28-29 | | To design & the operation of Waveform generators. | Triangular, saw tooth and Square waveform generators | T1 |
| 30 | | To understand the operation of 555 timer | Introduction to IC 555 timer, Description of functional diagram | |
| 31-32 | | To understand the oscillations using 555 timer. | Monostable and Astable operations and applications. | T1 |
| 33-36 | | To study the operation of PLL with a Block diagram | PLL -Introduction, basic principle, phase detector/comparator | T1 |
| 37 | III | To understand the basics of data converter | Introduction to data converters | T2 |
| 38 | | To understand the basics of DAC's,and the operation of weighted resistor DAC | Introduction, basic DAC techniques - weighted resistor DAC | T2 |
| 39-40 | | To know the disadvantage of weighted resistor DAC, and the operation of R-2R ladder DAC and Inverted Ladder DAC | R-2R ladder DAC, inverted R-2R DAC | T2 |
| 41-42 | | To know the basics of ADC's, and the operation of Parallel type and Counter type ADC | A to D converters - parallel comparator type ADC, counter type ADC | T2 |
| 43-44 | | To understand the Operation of Successive Approximation type ADC and Dual slope ADC | Successive approximation ADC , Dual slope ADC | T2 |
| 45 | | To study the specifications of DAC's and ADC's | DAC and ADC Specifications | T2 |
| 46 | IV | To know the basics of digital integrated circuits and classification | digital integrated circuits and classification | T2 |
| 47 | | To study the comparison of various logic families | comparison of various logic families | T2 |
| 48 | | To know CMOS logic levels and design of Inverter using CMOS | CMOS logic levels, MOS transistors, Basic CMOS Inverter | T2 |
| 49-51 | | To know the operation and design of NAND and NOR gates using CMOS | NAND AND NOR GATES, CMOS AND-OR-INVERT AND OR-AND-INVERT GATES | T2 |
| 52 | | To know the procedure for implementing functions using CMOS | Implementation of any function using CMOS logic. | T2 |
| 53 | | To know the basics of Logic gates using ICs | 74XX ICS: Study of logic gates using 74XX ICs | T2 |
| 54 | | To know the basics of Logic gates using ICs | 40XX ICS: Study of logic gates using 40XX ICs | T2 |
| 55 | | To study Adder and comparator using IC 74XX series | Four-bit parallel adder(IC 7483), Comparator(IC 7485) | T2 |
| 56 | | To study Decoder using IC 74XX series | Decoder(IC 74138, IC 74154), BCD-to-7-segment decoder(IC 7447) | T2 |
| 57 | | To study Encoder using IC 74XX series. | Encoder(IC 74147) | T2 |
| 58 | | To study Multiplexer using IC 74XX series. | Multiplexer(IC 74151) | T2 |

| | | | | |
|---|---|---|---|---|
| 59 | **IV** | To study Demultiplexer using IC 74XX series | Demultiplexer (IC 74154). | T2 |
| 60 | | To study Priority generators/checkers | Priority generators/checkers | |
| 61 | | To study parallel binary adder/subtractor,magnitude comparators | Priority generators/checkers | T2 |
| 62-63 | **V** | To study Flip-Flops using IC 74XX series | SEQUNTIAL CIRCUITS USING TTL 74XX ICS: Flip Flops (IC 7474, IC 7473) | T2 |
| 64 | | To study Shift registers using IC 74XX series | Shift Registers, Universal Shift Register(IC 74194) | T2 |
| 65 | | To study Counters using IC 74XX series | 4- bit asynchronous binary counter(IC 7493). | T2 |
| 66 | | To study memories | ROM Architectures and applications | T2 |
| 67-69 | | To study types of memories and applications | RAM Architectures Static and Dynamic RAMs | T2 |

## X. MAPPING COURSE OBJECTIVES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

| Course Objectives | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **1** | S | H | | | S | | | | S | | H | S | H | S | |
| **2** | S | H | | | | | | | | | | | H | S | |
| **3** | S | | | | S | | | | | | H | S | S | H | |
| **4** | | H | S | | | | | | | | | | H | S | |
| **5** | | | S | | | | | | | | | | H | | S |
| **6** | S | | | | S | | | | | | | | H | S | S |

**S – Supportive** **H - Highly Related**

## XI. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

| Course Outcomes | Program Outcomes | | | | | | | | | | | | Program Specific Outcomes | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| 1 | S | H | | | | | | | | | H | S | H | S | |
| 2 | S | | S | | | | | | S | | | | S | H | |
| 3 | | H | S | | S | | | | | | | | H | S | |
| 4 | | | S | | | | | | | | | | S | H | |
| 5 | | S | | | | | | | S | | | | S | H | |
| 6 | | H | | | | | | | | | H | | H | S | |
| 7 | S | | | | S | | | | S | | | | S | H | |
| 8 | S | H | | | | | | | | | | S | H | S | |
| 9 | S | H | | | | | | | | | | S | S | H | |
| 10 | H | | | S | | | | | | | | | S | H | S |
| 11 | | H | S | | S | | | | | | | | H | S | |
| 12 | | | S | | | | | | | | | | S | H | |
| 13 | | S | | | | | | | S | | | | S | H | |

**S – Supportive** **H - Highly Related**

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**Date** : 12th July, 2017

**HOD, ECE**