**INSTITUTE OF AERONAUTICAL ENGINEERING**

**(Autonomous)**
Dundigal, Hyderabad -500 043

# ELECTRONICS AND COMMUNICATION ENGINEERING

## COURSE DESCRIPTOR

| | | | | | |
|---|---|---|---|---|---|
| **Course Title** | **ELECTRONIC CIRCUIT ANALYSIS** | | | | |
| **Course Code** | AEC004 | | | | |
| **Programme** | B.Tech | | | | |
| **Semester** | IV | ECE | | | |
| **Course Type** | Core | | | | |
| **Regulation** | IARE - R16 | | | | |
| **Course Structure** | **Theory** | | | **Practical** | |
| | **Lectures** | **Tutorials** | **Credits** | **Laboratory** | **Credits** |
| | 3 | 1 | 3 | 3 | 2 |
| **Chief Coordinator** | Mr. J. Siva Ramakrishna, Assistant Professor | | | | |
| **Course Faculty** | Ms. G. Mary Swarna Latha, Assistant Professor<br>Mr. C. Srihari, Assistant Professor | | | | |

## I. COURSE OVERVIEW:

The course will make them learn the basics to design and analysis of single stage and multistage amplifiers. Demonstrate the ability to analyze the frequency response of different types of amplifiers. Interpret the concept of feedback and classify various types of feedback amplifiers. Understand the principle of oscillation and design different types of oscillators. Further, design concepts of large signal (power) amplifiers are explained.

## II. COURSE PRE-REQUISITES:

| Level | Course Code | Semester | Prerequisites | Credits |
|---|---|---|---|---|
| UG | AEC001 | III | Electronic Devces and Circuits | 4 |

## III. MARKS DISTRIBUTION:

| Subject | SEE Examination | CIA Examination | Total Marks |
|---|---|---|---|
| Electronic Circuit Analysis | 70 Marks | 30 Marks | 100 |

## IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ✔ | Chalk & Talk | ✔ | Quiz | ✔ | Assignments | ✘ | MOOCs |
| ✔ | LCD / PPT | ✔ | Seminars | ✔ | Mini Project | ✘ | Videos |
| ✘ | Open Ended Experiments | | | | | | |

## V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

**Semester End Examination (SEE):** The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five units and each unit carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each unit. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

| | |
|---|---|
| 50 % | To test the objectiveness of the concept. |
| 50 % | To test the analytical skill of the concept OR to test the application skill of the concept. |

**Continuous Internal Assessment (CIA):**
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

| **Component** | **Theory** | | **Total Marks** |
|---|---|---|---|
| **Type of Assessment** | CIE Exam | Quiz / AAT | |
| **CIA Marks** | 25 | 05 | 30 |

**Continuous Internal Examination (CIE):**
Two CIE exams shall be conducted at the end of the 8$^{th}$ and 16$^{th}$ week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

**Quiz / Alternative Assessment Tool (AAT):**
Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, five minutes video and MOOCs.

## VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

| Program Outcomes (POs) | | Strength | Proficiency assessed by |
|---|---|---|---|
| PO 1 | **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems. | 3 | Lectures, Assignments, Exercises |
| PO 2 | **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences | 2 | Lab related exercises |
| PO 5 | **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations. | 1 | Design Exercises |
| PO 12 | **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. | 1 | Development of Mini Projects |

**3 = High; 2 = Medium; 1 = Low**

## VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

| Program Specific Outcomes (PSOs) | | Strength | Proficiency assessed by |
|---|---|---|---|
| PSO 1 | **Professional Skills:** An ability to understand the basic concepts in Electronics and Communication engineering and to apply them to various areas, like Electronics, Communications, Signal processing, VLSI, Embedded systems etc., in the design and implementation of complex systems. | 3 | Lectures and Assignments. |
| PSO 2 | **Problem-Solving Skills:** An ability to solve complex Electronics and Communication Engineering problems, using latest hardware and software tools, along with analytical skills to arrive cost effective and appropriate solutions. | - | - |
| PSO 3 | **Successful Career and Entrepreneurship:** An understanding of social-awarness and environmental-wisdom along with ethical responsibility to have a successful career and to sustain passion and zeal for real world applications using optimal resources as an Enterpreneur. | 2 | Guest lectures |

**3 = High; 2 = Medium; 1 = Low**

## VIII. COURSE OBJECTIVES (COs):

| The course should enable the students to: | |
|---|---|
| I | Design and analyse single stage and multi stage Amplifiers |
| II | Analyse the frequency response of different types of Amplifiers |
| III | Interpret the concept of feedback and classify various types of feedback amplifiers |
| IV | Understand the principle of oscillation and design different types of oscillators |

## IX. COURSE LEARNING OUTCOMES (CLOs):

| CLO Code | CLO's | At the end of the course, the student will have the ability to: | PO's Mapped | Strength of Mapping |
|---|---|---|---|---|
| AEC004.01 | CLO 1 | Design various amplifier circuits using Bipolar Junction Transistors in Common | PO 1, PO2, PO12 | 2 |

| CLO Code | CLO's | At the end of the course, the student will have the ability to: | PO's Mapped | Strength of Mapping |
|---|---|---|---|---|
| | | Emitter, Common Base and Common Collector configurations. | | |
| AEC004.02 | CLO 2 | Understand the effect of coupling and bypass capacitances on frequency response of single stage amplifiers. | PO 1,PO2, PO12 | 2 |
| AEC004.03 | CLO 3 | Analyse various BJT amplifier circuits and their frequency responses at low, mid and High frequencies. | PO1, PO 2, PO5 | 2 |
| AEC004.04 | CLO 4 | Apply the usefulness of amplifiers using semiconductor devices in various real time circuit making. | PO 2, PO5 | 2 |
| AEC004.05 | CLO 5 | Understand and Remember the concept of Bipolar Junction Transistor amplifiers at high frequencies. | PO1, PO5 | 2 |
| AEC004.06 | CLO 6 | Analyse various high frequency parameters like Conductance's, resistances and Capacitances in Hybrid-$\pi$ model. | PO 2, PO12 | 2 |
| AEC004.07 | CLO 7 | Design RC, Transformer and Direct coupling techniques used in multi stage amplifiers and also Remember the differences between them. | PO 1, PO5, PO12 | 2 |
| AEC004.08 | CLO 8 | Analyze various multistage amplifiers such as Darlington, Cascode (Common Emitter-Common Base) etc. | PO 1, PO5 | 2 |
| AEC004.09 | CLO 9 | Design the tuned circuits used in single tuned amplifier, double tuned amplifiers and stagger tuned amplifiers. | PO 2, PO5, PO12 | 2 |
| AEC004.10 | CLO 10 | Understand and Remember the conditions required by an electronic circuit using Bipolar Junction Transistor to act like an Oscillator. | PO 1, PO12 | 2 |
| AEC004.11 | CLO 11 | Design various sinusoidal Oscillators like RC Phase shift, Wien bridge, Hartley and Colpitts oscillator for various frequency ranges. | PO 1, PO2 | 2 |
| AEC004.12 | CLO 12 | Analyse the importance of positive feedback and negative feedback in connection in electronic circuits. | PO 1, PO2, PO12 | 2 |
| AEC004.13 | CLO 13 | Analyze various types of feedback amplifiers like voltage series, current series, current shunt and voltage shunt. | PO 1, PO2, PO12 | 2 |
| AEC004.14 | CLO 14 | Interpret the difference between small signal amplifiers and large signal amplifiers using Bipolar Junction Transistors. | PO 5, PO12 | 1 |
| AEC004.15 | CLO 15 | Understand types of power amplifiers based on position of Quiescent or operating point on load lines and also understand its parameters. | PO 1 | 3 |
| AEC004.16 | CLO 16 | Design different types of power amplifiers for practical applications of desired specifications like efficiency, output power, | PO 5 | 1 |

| CLO Code | CLO's | At the end of the course, the student will have the ability to: | PO's Mapped | Strength of Mapping |
|---|---|---|---|---|
| | | distortion etc. | | |
| AEC004.17 | CLO 17 | Acquire experience in building and troubleshooting simple electronic analog circuits using Bipolar Junction Transistor. | PO 1, PO5 | 2 |
| AEC004.18 | CLO 18 | Acquire the knowledge and develop capability to succeed national and international level competitive examinations. | PO 1, PO5 | 2 |

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

| CLO | Program Outcomes (POs) | | | | | | | | | | | | Program Specific Outcomes (PSOs) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CLO 1 | 3 | 2 | | | | | | | | | | 1 | 3 | | |
| CLO 2 | 3 | 2 | | | | | | | | | | 1 | 3 | | |
| CLO 3 | 3 | 2 | | | 1 | | | | | | | | 3 | | |
| CLO 4 | | 2 | | | 1 | | | | | | | | | | |
| CLO 5 | 3 | | | | 1 | | | | | | | | | | 2 |
| CLO 6 | | 1 | | | | | | | | | | 3 | 3 | | |
| CLO 7 | 3 | | | | 1 | | | | | | | 1 | 3 | | |
| CLO 8 | 1 | | | | 1 | | | | | | | | 3 | | |
| CLO 9 | | 2 | | | 2 | | | | | | | 1 | 3 | | |
| CLO 10 | 3 | | | | | | | | | | | 1 | 3 | | |
| CLO 11 | 3 | 2 | | | | | | | | | | | | | |
| CLO 12 | 2 | 3 | | | | | | | | | | 2 | 3 | | 2 |
| CLO 13 | 3 | 2 | | | | | | | | | | 1 | | | |
| CLO 14 | | | | | 1 | | | | | | | 1 | 3 | | 2 |
| CLO 15 | 3 | | | | | | | | | | | | | | |
| CLO 16 | | | | | 3 | | | | | | | | 3 | | 2 |
| CLO 17 | 2 | | | | 1 | | | | | | | | 3 | | 2 |
| CLO 18 | 3 | | | | 1 | | | | | | | | 3 | | |

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## XI. ASSESSMENT METHODOLOGIES – DIRECT

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CIE Exams | PO 1, PO 2, PO 5 | SEE Exams | PO 1, PO 2, PO 5,PO 12 | Assignments | PO 1 | Seminars | PO 2 |
| Laboratory Practices | PO 1 | Student Viva | - | Mini Project | - | Certification | - |
| Term Paper | - | | | | | | |

## XII. ASSESSMENT METHODOLOGIES - INDIRECT

| | | | |
|---|---|---|---|
| ✔ | Early Semester Feedback | ✔ | End Semester OBE Feedback |
| ✘ | Assessment of Mini Projects by Experts | | |

## XIII. SYLLABUS

**UNIT – I**

**SINGLE STAGE AMPLIFIERS AND FREQUENCY RESPONSE :**

Classification of amplifiers, overview of analysis of a transistor amplifier circuit using h-parameter, Millers theorem and its dual, design of Single stage RC coupled amplifier using bipolar junction transistor, low frequency response of bipolar junction transistor amplifier, analysis at low frequency, effect of coupling and bypass capacitor.

**UNIT – II**

**HIGH FREQUENCY RESPONSE OF AMPLIFIER :**

The hybrid-π common emitter transistor model, hybrid π conductance and capacitance, effect of coupling and bypass capacitors, common emitter short circuit current gain, current gain with resistive load, alpha, beta cut-off frequencies, gain bandwidth product ,emitter follower at high frequencies.

**UNIT – III**

**MULTI STAGE AMPLIFIERS AND TUNED AMPLIFIERS :**

Multistage amplifier: Different coupling schemes used in amplifiers, RC coupled amplifiers, transformer coupled amplifiers and direct coupled amplifiers, analysis of cascaded RC coupled bipolar junction transistor amplifiers, cascode amplifiers, Darlington pair.

Tuned amplifiers: introduction, Q - factor, small signal tuned amplifier, effect of cascading single tuned amplifiers on bandwidth, stagger tuned amplifiers, stability of tuned amplifiers.

**UNIT – IV**

**FEEDBACK AMPLIFIERS AND OSCILLATORS :**

Feedback amplifiers: Concept of feedback, classification of feedback amplifiers, general characteristics of negative feedback amplifiers, analysis of voltage series, voltage shunt, current series and current shunt feedback configurations, problems;

Oscillators: Classification of oscillator, conditions for oscillations, RC phase shift oscillator, generalized analysis of LC oscillations, Hartley and Colpitts oscillators, Wien - bridge and crystal oscillators, stability of oscillators.

**UNIT – V**

**LARGE SIGNAL AMPLIFIERS:**

Classification, class A large signal amplifiers, transformer coupled class A audio power amplifiers, efficiency of class A amplifier, class B amplifier, efficiency of class B amplifier,

class B push-pull amplifier, complementary symmetry class B push-pull amplifier, distortion in power amplifiers, thermal stability and heat sinks.

**TEXT BOOKS:**


| | |
|---|---|
| 1 | Jacob Millman , Christor C Halkias, ―Integrated Electronics‖, Tata McGraw Hill, 1st Edition, 2008. |
| 2 | Sedra A.S., K.C. Smith, ―Micro Electronic Circuits‖, Oxford University Press, 6th Edition, 2013. |
| 3 | Donald A Neamen, ― Electronic Circuits Analysis and Design‖ , Tata McGraw Hill , 3 rd Edition, 2007. |

**REFERENCES:**


| | |
|---|---|
| 1 | David A. Bell ―Electronic Devices & Circuits‖ 5th Edition,. Oxford university press, 7 th Edition, 2009 |
| 2 | S.Salivahna, N. Suresh kumar, ―Electronic circuit analysis‖, McGraw-Hill Education, 1 st Edition, 2011. |
| 3 | Robert L. Boylestad, Louis Nashelsky, ―Electronic Devices and Circuits Theory‖, Pearson education, 9 th Edition, 2008 |
| 4 | K. Lal Kishore, ―Electronic Circuit Analysis‖, BS Publications,1st Edition, 2004. |


## XIV. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

| Lecture No | Topics to be covered | CLOs | Reference |
|---|---|---|---|
| 1-3 | Describe Classification of amplifiers, overview of analysis of a transistor amplifier circuit using h-parameter. | CLO 1, CLO 2 | T1:22.5 R1:2.3 |
| 4-6 | Understand Millers theorem and its dual, design of Single stage RC coupled amplifier using bipolar junction transistor | CLO 2 | T1:22.5 R1:2.4 |
| 7-9 | Recall low frequency response of bipolar junction transistor amplifier, analysis at low frequency, effect of coupling and bypass capacitor.. | CLO 2 | T1:22.6 R1:2.6 |
| 10-14 | Describe The hybrid-π common emitter transistor model, hybrid π conductance and capacitance | CLO 3 | T1:22.7 R1:4.4 |
| 15-16 | Understand the effect of coupling and bypass capacitors. | CLO 2 | T1:22.7 R1:4.10 |
| 17-20 | Describe common emitter short circuit current gain, current gain with resistive load, alpha, beta cut-off frequencies. | CLO 5, CLO 6 | T1:22.8 R1:4.15 |
| 21-23 | Describe gain bandwidth product ,emitter follower at high frequencies | CLO 6 | T1:22.9 R1:5.4 |
| 24-27 | Understand multistage amplifier: Different coupling schemes used in amplifiers, RC coupled amplifiers, transformer coupled amplifiers and direct coupled amplifiers | CLO 7, CLO 8 | T1:22.9 R1:5.8 |
| 28-30 | Analysis of cascaded RC coupled bipolar junction transistor amplifiers, cascode amplifiers, Darlington pair.. | CLO 7 | T1:23.10 R1:6.8 |
| 31-34 | Describe tuned amplifiers introduction, Q - factor, small signal tuned amplifier, effect of cascading single tuned amplifiers on bandwidth, stagger tuned amplifiers, stability of tuned amplifiers. | CLO 9 | T1:23.10 R1:6.13 |
| 35-38 | Identify feedback amplifiers: Concept of feedback, classification of feedback amplifiers, general characteristics of negative feedback amplifiers, analysis of voltage series, voltage shunt | CLO 10, CLO 11 | T1:23.9 R1:7.5 |
| 39-41 | Distinguish current series and current shunt feedback configurations, problem | CLO 12 | T1:23.10 R1:7.5 |
| 41-43 | Understand oscillators: Classification of oscillator, conditions for oscillations, RC phase shift oscillator | CLO 10 | T1:23.10 R1:8.1 |
| 44-46 | Describe generalized analysis of LC oscillations, Hartley and Colpitts oscillators, Wien - bridge and crystal oscillators, stability of oscillators. | CLO 12 | T1:23.1 R1:9.2 |
| 47-50 | Explain efficiency of class A amplifier, class B amplifier, efficiency of class B amplifier, class B push-pull amplifier | CLO 13, CLO 14 | T1:23.1 R1:9.4 |

| Lecture No | Topics to be covered | CLOs | Reference |
|---|---|---|---|
| 51-60 | Describe complementary symmetry class B push-pull amplifier, distortion in power amplifiers, thermal stability and heat sinks | CLO 15 | T1:23.1<br>R1:9.9 |

## XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

| S NO | Description | Proposed actions | Relevance with POs | Relevance with PSOs |
|---|---|---|---|---|
| 1 | To improve standards and analyze the concepts. | Seminars | PO 1 | PSO 1 |
| 2 | Conditional probability, Sampling distribution, correlation, regression analysis and testing of hypothesis | Seminars / NPTEL | PO 2 | PSO 1 |
| 3 | Encourage students to solve real time applications and prepare towards competitive examinations. | NPTEL | PO 5 | PSO 3 |

**Prepared by:**
Mr. J Siva Ramakrishna, Assistant Professor

**HOD, ECE**