INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

ELECTRICAL AND ELECTONICS ENGINEERING

COURSE DESCRIPTOR

Course Title	**ANALOG ELECTRONICS**				
Course Code	AECB02				
Programme	B.Tech				
Semester	III	EEE			
Course Type	Core				
Regulation	IARE - R18				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Mrs. M Sreevani, Assistant Professor				
Course Faculty	Mr. P Sandeep Kumar, Assistant Professor				

I. COURSE OVERVIEW:

This course is designed to build on students' already established knowledge in Waves and Optics and Electrical Circuits. The course introduces the basic electronic devices to Electrical and Electronics Engineering students. Students examine the building blocks of analog electronics through graphical, analytical and computer tools. Upon completion of the class, students should be proficient in electronics.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AEEB03	II	Electrical Circuits	4
UG	AHSB04	II	Waves and Optics	4

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Analog Electronics	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 modules and each module 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 module. 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 20 marks for Continuous Internal Examination (CIE), 05 marks for Quiz and 05 marks for Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	**Theory**			**Total Marks**
Type of Assessment	CIE Exam	Quiz	AAT	
CIA Marks	20	05	05	30

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 20 marks of 2 hours duration consisting of five descriptive type questions out of which four 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 - Online Examination

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are to be answered by choosing the correct answer from a given set of choices (commonly four). Such a question paper shall be useful in testing of knowledge, skills, application, analysis, evaluation and understanding of the students. Marks shall be awarded considering the average of two quiz examinations for every course.

Alternative Assessment Tool (AAT)

This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning centre. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCs etc.

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.	2	Quiz
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	Seminars
PO 3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	2	Assignments
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	2	Discussion of real-time applications

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:** 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.	1	Seminars
PSO 2	**Problem Solving Skills:** To 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.	-	-

PSO 3	**Successful career and entrepreneurship:** To be able to utilize of technologies like PLC, PMC, process controllers, transducers and HMI and design, install, test, maintain power systems and industrial applications.	-	-

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VIII. COURSE OBJECTIVES :

The course should enable the students to:	
I	Explain the components such as diodes, BJTs and FETs their switching characteristics, application.
II	Learn the concepts of high frequency analysis of transistors.
III	Describe the various types of basic and feedback amplifier circuits such as small signal, cascaded, large signal and tuned amplifiers.
IV	Discuss the basic building blocks of linear integrated circuits.
V	Understand the concepts of waveform generation and introduce some special function ICs.

IX. COURSE OUTCOMES(COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	Describe the concept of diode and transistor operation with applications.	CLO 1	Understand the basic concept of PN diode with characteristics.
		CLO 2	Analyze the application of diode in Rectifiers, clippers and clampers.
		CLO 3	Understand the working of different configurations of Bipolar Junction Transistor.
		CLO 4	Design the various biasing circuits.
		CLO 5	Analyze the different types of Amplifiers with BJT.
CO 2	Understand the principle of operation of MOSFET in CS, CG, CD amplifiers and analyze MOSFET with high frequency equivalent circuit.	CLO 6	Understand the principle of operation of MOSFET and as switch.
		CLO 7	Apply small-signal model to MOSFET and determine the voltage gain and input and output impedances.
		CLO 8	Analyze the MOSFET characteristics of common source, common gate and common drain amplifiers.
		CLO 9	Determine the parameters of MOSFET amplifier from drain and transfer characteristics.
		CLO 10	Analyze the high frequency equivalent circuit model of MOSFET.
CO 3	Analyze the different types of multistage amplifiers and Power amplifiers.	CLO 11	Understand the classification of transistor amplifiers.
		CLO 12	Understand the different coupling schemes used in amplifiers.
		CLO 13	Analyze frequency response of multistage amplifiers.
		CLO 14	Analyze hybrid-pi model of BJT.
		CLO 15	Analyze the different types of power amplifiers.

CO 4	Study and analyze the different characteristics of feedback amplifiers and oscillators.	CLO 16	Understand the concept of characteristics of feedback amplifiers.
		CLO 17	Analyze the different configurations of feedback amplifiers.
		CLO 18	Distinguish the constructional features and operation of feedback amplifiers and oscillators.
		CLO 19	Understand the basic concept of condition for oscillations.
		CLO 20	Analyze the different types of oscillators.
CO 5	Understand the principle of operation of Op-amp characteristics with different applications.	CLO 21	Understand the basic concept Operational amplifier.
		CLO 22	Analyze different characteristics of OP-amp.
		CLO 23	Understand the different types of op-amp based on input.
		CLO 24	Analyze the different applications of Op-amp.
		CLO 25	Design the different types of waveform generators.

X. MAPPING COURSE OUTCOMES LEADING TO THE ACHIVEMENT OF PROGRAM OUTCOMES:

Course Outcomes (COs)	Program Outcomes (PO)					
	PO 1	PO 2	PO 3	PO 6	PSO 1	PSO 2
CO 1	2	3	1	1	1	
CO 2	2	2	1	1	1	
CO 3	2	3				
CO 4	2	2			1	
CO 5	2	2	1	1	1	

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XI. 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
AEC001.01	CLO 1	Understand the basic concept of PN diode with characteristics.	PO1, PO2 &PO6	2
AEC001.02	CLO 2	Analyze the application of diode in Rectifiers, clippers and clampers.	PO1, PO2	2
AEC001.03	CLO 3	Understand the working of different configurations of Bipolar Junction Transistor.	PO1, PO2	2
AEC001.04	CLO 4	Design the various biasing circuits.	PO1, PO3	2
AEC001.05	CLO 5	Analyze the different types of Amplifiers with BJT.	PO1, PO2	2
AEC001.06	CLO 6	Understand the principle of operation of MOSFET and as switch.	PO1	2

AEC001.07	CLO 7	Apply small-signal model to MOSFET and determine the voltage gain and input and output impedances.	PO1, PO3 & PO6	2
AEC001.08	CLO 8	Analyze the MOSFET characteristics of common source, common gate and common drain amplifiers.	PO1, PO2	2
AEC001.09	CLO 9	Determine the parameters of MOSFET amplifier from drain and transfer characteristics.	PO1, PO2	2
AEC001.10	CLO 10	Analyze the high frequency equivalent circuit model of MOSFET.	PO3	2
AEC001.11	CLO 11	Understand the classification of transistor amplifiers.	PO1	2
AEC001.12	CLO 12	Understand the different coupling schemes used in amplifiers.	PO1, PO2	2
AEC001.13	CLO 13	Analyze frequency response of multistage amplifiers.	PO1	2
AEC001.14	CLO 14	Analyze hybrid-pi model of BJT.	PO1	2
AEC001.15	CLO 15	Analyze the different types of power amplifiers.	PO1	2
AEC001.16	CLO 16	Understand the concept of characteristics of feedback amplifiers.	PO1	2
AEC001.17	CLO 17	Analyze the different configurations of feedback amplifiers.	PO1, PO2	2
AEC001.18	CLO 18	Distinguish the constructional features and operation of feedback amplifiers and oscillators.	PO1, PO2	2
AEC001.19	CLO 19	Understand the basic concept of condition for oscillations.	PO1	2
AEC001.20	CLO 20	Analyze the different types of oscillators.	PO1, PO2	2
AEC001.21	CLO 21	Understand the basic concept Operational amplifier.	PO1	3
AEC001.22	CLO 22	Analyze different characteristics of OP-amp.	PO1, PO2	2
AEC001.23	CLO 23	Understand the different types of op-amp based on input.	PO1, PO2	2
AEC001.24	CLO 24	Analyze the different applications of Op-amp.	PO1, PO2	2
AEC001.25	CLO 25	Design the different types of waveform generators.	PO2,PO3	2

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

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	2	2				2									
CLO 2	2	2											1		
CLO 3	2	2													

CLO 4	2		2												
CLO 5	1	2											2		
CLO 6	2														
CLO 7	1		2			2									
CLO 8	2	2													
CLO 9	2	2													
CLO 10			2										1		
CLO 11	2														
CLO 12	2	2											2		
CLO 13	2														
CLO 14	2														
CLO 15	2														
CLO 16	2														
CLO 17	2	2											1		
CLO 18	2	3													
CLO 19	1														
CLO 20	2	2													
CLO 21	3														
CLO 22	2	2											2		
CLO 23	2	2													
CLO 24	2	2													
CLO 25		2	2												

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XIII. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO 1	SEE Exams	PO 1	Assignments	-	Seminars	PO 2
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	PO 6						

XIV. ASSESSMENT METHODOLOGIES-INDIRECT

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

XV. SYLLABUS:

MODULE -I	DIODE CIRCUITS	Classes: 09
P-N junction diode, I-V characteristics of a diode; review of half-wave and full-wave rectifiers, clamping and clipping circuits. Input output characteristics of BJT in CB, CE, CC configurations, biasing circuits, Load line analysis, common emitter, common base and common collector amplifiers; Small signal equivalent circuits.		
MODULE - II	**MOSFET CIRCUITS**	**Classes: 09**
MOSFET structure and I-V characteristics. MOSFET as a switch. small signal equivalent circuits - gain, input and output impedances, small-signal model and common-source, common-gate and common-drain amplifiers, trans conductance, high frequency equivalent circuit.		
MODULE - III	**MULTI-STAGE AND POWER AMPLIFIERS**	**Classes: 09**
Classification of Amplifiers, Distortion in amplifiers, Different coupling schemes used in amplifiers, Frequency response and Analysis of multistage amplifiers, Cascade amplifier, Darlington pair. **Transistor at High Frequency:** Hybrid - model of Common Emitter transistor model, fα, β and unity gain bandwidth, Gain band width product. Differential Amplifiers, Power amplifiers - Class A, Class B, Class C, Class AB.		
MODULE - IV	**FEEDBACK AMPLIFIERS**	**Classes: 09**
Concepts of feedback: Classification of feedback amplifiers, general characteristics of Negative feedback amplifiers, effect of feedback on amplifier characteristics, voltage series, voltage shunt, current series and current shunt feedback configurations, simple problems; Oscillators: Condition for Oscillations, RC type Oscillators RC phase shift and Wien-bridge Oscillators, LC type Oscillators, generalized analysis of LC Oscillators, Hartley and Colpitts oscillators.		
MODULE - V	**OPERATIONAL AMPLIFIERS**	**Classes: 09**
Ideal op-amp, Output offset voltage, input bias current, input offset current, slew rate, gain bandwidth product, Inverting and non-inverting amplifier, Differentiator, integrator, Square-wave and triangular-wave generators.		
Text Books:		
1. Jacob Millman, Christos C Halkias, "Integrated Electronics", McGraw Hill Education, 2nd Edition 2010. 2. Ramakanth A Gayakwad, "Op-Amps & Linear ICS", PHI, 1st Edition, 2003.		
Reference Books:		
1. Electronic Devices – Conventional current version – Thomas L Floyd, 2015, Pearson 2. J Millman and A Grabel, "Microelectronics", McGraw Hill Education, 1988. 3. P Horowitz and W Hill, "The Art of Electronics", Cambridge University Press, 1989. 4. P. R Gray, R.G. Meyer and S. Lewis,"Analysis and Design of Analog Integrated Circuits", John Wiley & Sons, 2001.		

Web References:
1. https://www.mdp.eng.cam.ac.uk/web/library/enginfo/electrical/hong1.pdf 2. https://www.archive.org/details/ElectronicDevicesCircuits 3. https://www.nptel.ac.in/courses/webcourse-contents/IIT-ROORKEE/BASICELECTRONICS/home_page.htm 4. http://notes.specworld.in/pdc-pulse-and-digital-circuits/
E-Text Books:
1. https://services.eng.uts.edu.au/pmcl/ec/Downloads/LectureNotes.pdf 2. https://nptel.ac.in/courses/122106025 3. http://www.freebookcentre.net/electronics-ebooks-download/Electronic-Devices-and-Circuits-(PDF-313p).html 4. http://www.introni.it/pdf/Millmam-Taub-Pulse and Digital Switching Waveforms 1965.pdf 5. https://www.jntubook.com/pulse-digital-circuits-textbook-free-download/

XVI. COURSE PLAN:

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

Lecture No.	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1.	Understand the P-N junction diode.	CLO1	T1: 3.1
2.	Understand the P-N junction diode-FB & RB.	CLO1	T1: 3.2
3.	Understand the I-V characteristics of a diode.	CLO1	T1: 3.3-3.4
4.	Analysis of half-wave rectifiers-Vac, Irms, PIV.	CLO2	T1:4.8
5.	Analysis of half-wave rectifiers-Efficiency, Ripple factor.	CLO2	T1:4.8
6.	Analysis of full-wave rectifiers.	CLO2	T1: 4.9
7.	Analysis of Clipping circuits.	CLO2	T1: 4.4-4.5
8.	Analysis of Clamping circuits.	CLO2	T1: 4.11
9.	Analysis of Input output characteristics of BJT in CB configuration.	CLO3	T1: 5.1-5.5
10.	Analysis of Input output characteristics of BJT in CE configurations.	CLO3	T1: 5.6-5.10
11.	Analysis of Input output characteristics of BJT in CC configurations.	CLO3	T1: 5.11
12.	Design the different biasing circuits-Self bias.	CLO4	T1:9.3
13.	Design the different biasing circuits- Fixed bias.	CLO4	T2:9.2
14.	Understand the Load line analysis.	CLO4	T1: 9.1
15.	Analysis of common emitter amplifier.	CLO5	T1: 8.1-8.4
16.	Analysis of common base amplifier.	CLO5	T1: 8.1-8.4
17.	Analysis of common collector amplifiers.	CLO5	T1:8.8
18.	Design the Small signal equivalent circuits.	CLO5	T1: 8.6
19.	Understand the MOSFET structure.	CLO6	R1:7.4
20.	Analyze the I-V characteristics.	CLO6	R1:7.5
21.	Understand the concept of MOSFET as a switch.	CLO6	R1:7.5
22.	Design the small signal equivalent circuits.	CLO7	R1:8.1
23.	Determine the gain, input and output impedances.	CLO7	R1:8.1
24.	Apply small-signal model to MOSFET.	CLO7	R1:8.2
25.	Analyze the Common-source amplifier.	CLO8	R1:8.2
26.	Analyze the Common-gate amplifier.	CLO8	R1:8.3

27.	Analyze the Common-drain amplifier.	CLO8	R1:8.4
28.	Determine the Trans conductance.	CLO9	R1:8.4
29.	Analyze the high frequency equivalent circuit.	CLO10	R1: 8.4
30.	Understand the classification of Amplifiers.	CLO11	T1:12.1
31.	Understand the distortion in amplifiers.	CLO11	T1:12.2
32.	Analyze the different coupling schemes-Direct coupled.	CLO12	T1:12.7
33.	Analyze the different coupling schemes-Transformer coupled.	CLO12	T1:12.7
34.	Analyze the frequency response and Analysis of multistage amplifiers.	CLO13	T1: 12.8
35.	Analyze the Cascade amplifier.	CLO13	T1: 12.10
36.	Analyze the Darlington pair circuit.	CLO13	T1: 8.16
37.	Analyze the Hybrid – pi model of Common Emitter transistor model, fα, β.	CLO14	T1: 11.1
38.	Understand the unity gain bandwidth, Gain band width product.	CLO14	T1: 11.9
39.	Analyze the Differential Amplifiers-DIBO.	CLO14	T2:1.2
40.	Analyze the Differential Amplifiers-DIUO.	CLO14	T2:1.5
41.	Analyze the Differential Amplifiers-SIBO &SIUO.	CLO14	T2:1.6-1.7
42.	Analyze the Class A Power amplifiers.	CLO15	T1: 18.1
43.	Analyze the Class B Power amplifiers.	CLO15	T1:18.7
44.	Analyze the Class C Power amplifiers.	CLO15	R1:9.3
45.	Analyze the Class AB Power amplifiers.	CLO15	T1:18.8
46.	Understand the Concepts of feedback.	CLO16	T1:13.2
47.	Understand the Classification of feedback amplifiers.	CLO16	T1:13.7
48.	Understand the general characteristics of Negative feedback amplifiers.	CLO17	T1:13.4
49.	Analyze the effect of feedback on amplifier characteristics	CLO17	T1:14.1
50.	Analyze the voltage series feedback configuration.	CLO17	T1:13.9
51.	Analyze the voltage shunt feedback configuration.	CLO17	T1:13.12
52.	Analyze the current series and current shunt feedback configurations.	CLO17	T1:13.10-13.11
53.	Distinguish the constructional features and operation of feedback amplifiers and oscillators.	CLO18	R1:16.1
54.	Understand the Condition for Oscillations.	CLO19	R1:16.2
55.	Analyze the RC phase shift Oscillator.	CLO20	R1:16.3
56.	Analyze the Wien-bridge Oscillator.	CLO20	R1:16.3
57.	Analyze the Generalized analysis of LC Oscillators, Hartley and Colpitts oscillators.	CLO20	R1:16.4
58.	Understand the concept of Ideal op-amp.	CLO21	T2:3.3
59.	Determine the Output offset voltage, input bias current, input offset current, slew rate and gain bandwidth product.	CLO22	T2:5.1-5.11
60.	Analyze the Inverting and non-inverting amplifier.	CLO23	T1: 3.6,4.3-4.4
61.	Analyze the Differentiator and integrator.	CLO24	T2:7.12-7.13
62.	Design the Square-wave generator.	CLO25	T2:8.15
63.	Design the Triangular-wave generator.	CLO25	T2: 8.16

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

S No	Description	Proposed Actions	Relevance With POs
1	Analysis of JFET amplifiers.	Seminars / NPTEL	PO 1, PO 2
2	Voltage regulators	Seminars / NPTEL	PO 1, PO 2

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