ANALOG ELECTRONICS

Subject Code : EE303PC

Regulations : R18 - JNTUH

Class : II Year B.Tech EEE I Semester

Department of Electrical and Electronics and Engineering

BHARAT INSTITUTE OF ENGINEERING AND TECHNOLOGY

Ibrahimpatnam - 501 510, Hyderabad

ANALOG ELECTRONICS (EE303PC)

COURSE PLANNER

I. COURSEOVERVIEW:

- To introduce components such as diodes, BJTs and FETs their switching characteristics, applications and learn the concepts of high frequency analysis of transistors.
- To give understanding of various types of basic and feedback amplifier circuits such as small
- signal, cascaded, large signal and tuned amplifiers. To introduce the basic building blocks of linear integrated circuits.
- To introduce the concepts of waveform generation and introduce some special function ICs

II. PREREQUISITE(S):

- Basic of Electrical and Electronics.

III. COURSE OBJECTIVES:

- To introduce components such as diodes, BJTs and FETs their switching characteristics, applications and learn the concepts of high frequency analysis of transistors.
- To give understanding of various types of basic and feedback amplifier circuits such as small
- signal, cascaded, large signal and tuned amplifiers.
- To introduce the basic building blocks of linear integrated circuits.
- To introduce the concepts of waveform generation and introduce some special function ICs

IV. COURSE OUTCOMES:

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

S. No.	Course Outcomes (CO)	Knowledge Level (Blooms
CO1	Understand the concept of diode circuits	L2:UNDERSTAND
CO2	Explain about the concept and the characteristic's of mosfet circuits	L2:UNDERSTAND
CO3	Explain about the classification of power amplifiers	L2:UNDERSTAND L1:APPLY
CO4	Explain about the concept of feedback amplifiers & oscillators	L2:UNDERSTAND L1:APPLY

CO5	Understand the concept of operational amplifiers	L2:UNDERSTAND

V. HOW PROGRAM OUTCOMES AREASSESSED:

Program Outcomes (POs)		L	Proficiencyassessed by
PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex	3	Assignments
PO2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of	2	Assignments
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	2	Open ended experiments /
PO4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data,	2	Open ended experiments /
PO5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering	2	Mini Project
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	1	--
PO7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge	2	--
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice	1	--
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinarysettings	1	--
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	1	Seminars / Term Paper
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	-	--

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	1	Competitive Examinations

VI. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED

Program Specific Outcomes		Level	Proficiency assed by
PSO 1	Talented to analyze, design and implement electrical & electronics systems and deal with the rapid pace of industrial innovations and developments	1	Industrial visits, projects
PSO 2	Skillful to use application and control techniques for research and advanced studies in Electrical and Electronics engineering domain	1	Guest lecturers projects

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) - : None

VII. SYLLABUS:

UNIT - I

Diode Circuits: 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

UNIT - II

MOSFET Circuits: 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.

UNIT - III

Multi-Stage and Power Amplifiers: Direct coupled and RC Coupled multi-stage amplifiers; Differential Amplifiers, Power amplifiers - Class A, Class B, Class C

UNIT - IV

Feedback Amplifiers: 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.

UNIT - V

Operational Amplifiers: 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. Integrated Electronics, Jacob Millman, Christos C Halkias, McGraw Hill Education, 2nd edition 2010
2. Op-Amps & Linear ICs – Ramakanth A. Gayakwad, PHI, 2003.

REFERENCE BOOKS:

1. Electronic Devices Conventional and 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.

NPTEL Web Course:

nptel.ac.in/courses/108102095

VIII.COURSEPLAN:

Lecture no	week	Unit no	Topics to be covered	Course Learning Outcomes	Teaching Methodologie	References
1	1	1	**UNIT1: Introduction to Diode Circuits**	Understanding Concept of Diode Circuits	chalk & talk	T1, R2
2.			P-N junction diode		chalk & talk	T1, R2
3.			I-V characteristics of a diode		chalk & talk	T1, R2
4.			review of half-wave and full-wave rectifiers	Understanding Concept of Diode Circuits	chalk & talk	T1, R2
5.	2		clamping and clipping circuits		chalk & talk	T1, R2
6.			clamping and clipping circuits		chalk & talk	T1, R2
7.			Input output characteristics of BJT in CB, CE, CC configurations		chalk & talk	T1, R2
8.			Input output characteristics of BJT in CB, CE, CC configurations	Understanding Concept of Diode Circuits	chalk & talk	T1, R2
9.	3		biasing circuits		chalk & talk	T1, R2
10.			biasing circuits		chalk & talk	T1, R2
11.			Load line analysis common-emitter		chalk & talk	T1, R2

12.			Load line analysis common-base		chalk & talk	T1, R2
13.	4		Load line analysis common-collector requirements	Understanding Concept of Diode Circuits	chalk & talk	T2
14.			Small signal equivalent circuits		chalk & talk	T2
15.		2	**UNIT - II** **MOSFET Circuits**	Understanding Characteristics of MOSFET Circuits	chalk & talk	T2
16.			MOSFET structure and I-V characteristics		chalk & talk	T12
17.	5		MOSFET as a switch		chalk & talk	T2
18.			small signal equivalent circuits		chalk & talk	T2
19.			gain, input and output impedances	Understanding Characteristics of MOSFET Circuits	chalk & talk	T2
20.			small-signal model and common-source		chalk & talk	T2
21.	6		common-gate and common-drain amplifiers		chalk & talk	T2
22.			trans conductance		chalk & talk	T2
23.			high frequency equivalent circuit	Understanding Concept of Multi-Stage Amplifiers And Power Amplifiers	PPT	T1
24.		3	**UNIT - III** **Multi-Stage and Power Amplifiers**		PPT	T1
25.	7		Direct coupled and RC Coupled multi-stage amplifiers		PPT	T1
26.			Direct coupled and RC Coupled multi-stage amplifiers	Understanding Concept of Multi-Stage Amplifiers And Power Amplifiers	PPT	T1
27.			Direct coupled and RC Coupled multi-stage amplifiers		PPT	T1
28.			Differential Amplifiers	Understanding Concept of Multi-Stage Amplifiers And Power Amplifiers	PPT	T1
29.	8		Differential Amplifiers		chalk & talk	T1
30.			Power amplifiers - Class A		chalk & talk	T1
31.			Power amplifiers - Class B		chalk & talk	T1
32.			Power amplifiers - Class C		chalk & talk	T1
33.	9	4	UNIT - IV Feedback Amplifiers	Understanding Concept of Feedback Amplifiers	chalk & talk	T1
34.			Concepts of feedback		chalk & talk	T1

35.			Classification of feedback amplifiers		chalk & talk	T1
36.			characteristics of Negative feedback amplifiers	Understanding Concept of Feedback Amplifiers	chalk & talk	T1
37.	10		Effect of Feedback on Amplifier characteristics – Voltage series		chalk & talk	T1
38.			Effect of Feedback on Amplifier characteristics – Voltage shunt	Understanding Concept of Feedback Amplifiers	chalk & talk	T1
39.			Current series and Current shunt Feedback configurations		chalk & talk	T1
40.			Current series and Current shunt Feedback configurations		chalk & talk	T1
41.	11		Simple problems.		chalk & talk	T1
42.			Oscillators: Condition for Oscillations	Understanding Concept of Oscillators	chalk & talk	T1
43.			RC type Oscillators-RC phase shift and Wien-bridge Oscillators		chalk & talk	T1
44.			LC type Oscillators –Generalized analysis of LC Oscillators,		chalk & talk	T1
45.			Hartley and Colpitts Oscillators		chalk & talk	T1
46.			Hartley and Colpitts Oscillators		PPT	T1
47.	**12**		UNIT - V Operational Amplifiers		PPT	T1
48.			Ideal op-amp,		PPT	T1
49.			Output offset voltage, input bias current, input offset current, slew	Understanding	PPT	T1
50.			Output offset voltage, input bias current, input offset current, slew		PPT	T1
51.			Output offset voltage, input bias current, input offset current, slew	Understanding Concept of Operational Amplifiers	chalk & talk	T1
52.	13	5	gain bandwidth product		chalk & talk	T1
53.			Inverting and non-inverting amplifier		PPT	T1
54.			Inverting and non-inverting amplifier		chalk & talk	T1
55.			Differentiator	Understanding Concept of Operational Amplifiers	chalk & talk	T1
56.			integrator, Square-wave and triangular-wave generators.		chalk & talk	T1
57.	14		integrator, Square-wave and triangular-wave generators.		chalk & talk	T1

58.			**Topics beyond Syllabus: Concept of piecewise linear**		chalk & talk, PPT	
59.			**Transistor as a switch**		chalk & talk, PPT	
60.			**Revision**		chalk & talk	R11
61.			**Revision**		chalk & talk	R11

IX. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFICOUTCOMES:

Course Outcomes	Program Outcomes (PO)												Program Specific Outcomes (PSO)	
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	2	2	1	1	-	-	-	-	-	-	1	1	1
CO2	2	1	1	1	1	-	-	-	-	-	-	1	1	1
CO3	2	2	2	1	1	-	-	-	-	-	-	1	1	1
CO4	2	2	2	1	1	-	-	-	-	-	-	1	1	1
CO5	2	1	1	1	1	-	-	-	-	-	-	1	1	1
Avg	2	1.6	1.6	1	1	-	-	-	-	-	-	1	1	1

1:Slight(Low) 2:Moderate(Medium) 3: Substantial (High) - : None

X. QUESTION BANK (JNTUH)

UNIT – I

Short Answer Questions:

S.NO	Questions	Blooms Taxonomy Level	CO
1.	Draw the V-I characteristics of a diode	Understanding	1
2.	Define clipper & clamper	Understanding	1

3.	Draw the out put of a half wave rectifier	Understanding	1
4.	Draw the out put of a half wave rectifier	Understanding	1
5.	Draw the symbols of BJT ,Diode,SCR	Understanding	1

Long Answer Questions

S.NO	Questions	Blooms Taxonomy Level	Course Outcome
1	Explain in detail about clipping and clamping circuits	Understanding	1
2	Sketch the circuit of a CS amplifier. Derive the expression for the voltage gain at low Frequencies. What is the maximum value of voltage gain?	Understand, Apply	1
3	Explain in detail about the characteristics of BJT with CC,CB,CE configurations .	Understanding	1
4	Explain in detail about the operation of half wave and full wave rectifier.	Applying	1
5	Explain in detail about the operation of CC,CB,CE amplifiers.	Applying	

UNIT – II

Short Answer Questions:

S.No	Questions	Blooms Taxonomy Level	CO
1.	Draw the symbol of MOSFET	Understanding	2
2.	Draw the v-i characteristics of MOSFET	Understanding	2
3.	How MOSFET is used as a switch	Understanding	2
4.	Applications of MOSFET	Understanding	2
5.	Compare FET and MOSFET	Understanding	2

Long Answer Questions

S.No	Questions	Blooms Taxonomy Level	CO
1	Explain in detail about the V-I characteristics of MOSFET.	Understanding	2

2	Explain in detail about small signal equivalent circuits - gain , input and output impedances.	Understanding	2
3	Explain in detail about common source configuration of MOSFET	Understanding	2
4	Explain in detail about common gate configuration of MOSFET	Understanding	2
5	Explain in detail about common drain configuration of MOSFET	Understanding	2

UNIT – III

Short Answer Questions:

S.NO	Questions	Blooms Taxonomy Level	Course Outcome
1	What is the maximum efficiency of class-A amplifier?	Understanding	3
2	Draw a circuit for transformer coupled amplifier.	Applying,Creating	3
3	Explain the waveform of push-pull class-B power amplifier.	Understanding	3
4	What is thermal runway?	Understanding	3
5	Derive the expression for power dissipation in amplifier. Explain why heat sink is required.	Applying	3

Long Answer Questions:

S.NO	Questions	Blooms Taxonomy Level	Course Outcome
	a) A single stage class A amplifier V_{cc}=20V, V_{CEQ}=10V, I_{CQ} =600mA, R_L=16 Ω. The ac output current varies by 300mA, with the ac input signal. Find i) The power supplied by the dc source to the amplifier circuit. ii) AC power consumed by the load resistor. iii) AC power developed across the load resistor. iv) DC power wasted in transistor collector. v) Overall efficiency vi) Collector efficiency. b). List the advantages of complementary-symmetry configuration over push pull configuration.	Applying	3

2	a)Derive the expression for maximum conversion efficiency for a simple series fed Class A power amplifier. b) What are the drawbacks of transformer coupled power amplifiers? c) A push pull amplifier utilizes a transformer whose primary has a total of 160 turns and whose secondary has 40 turns. It must be capable of delivering 40W to an 8Ω load under maximum power conditions. What is the minimum possible value of V_{cc}?	Applying	3
3	a) With the help of a suitable circuit diagram, show that the maximum conversion efficiency of a class B power amplifier is 78.5%. b) Explain how Total harmonic distortion can be reduced in a Class B push-pull configured amplifier.	Analyze	3
4	a)State the merits of using push pull configuration?Describe the operation of class B push pull amplifier and show how even harmonics are eliminated. b) A single ended class A amplifier has a transformer coupled load of 8 Ω. If the transformer turns ratio is 10, find the maximum power output delivered to the load. Take the zero signal collector current of 500mA.	Analyze, Applying	3
5	(a) what is push-pull configuration and how does this circuit reduce the harmonic Distortion? (b)For a class B amplifier providing a 20V peak signal to a 16 load operates on a power supply of Vcc = 30V. Determine the input power, output power and circuit efficiency.	Analyze, Applying	3

UNIT – IV

Short Answer Questions:

S.NO	Questions	Blooms Taxonomy Level	Course Outcome
1	What are the advantages of negative feedback in amplifiers?	Understanding	4
2	Explain the effect of feedback in amplifier circuits.	Understanding	4
3	Derive the condition for oscillation	Understanding	4
4	Explain the operation of RC-phase shift oscillator.	Understanding	4
5	Difference between Hartley and Colpitt oscillator	Understanding	4

Long Answer Questions:

S.NO	Questions	Blooms Taxonomy Level	Course Outcome
1	Derive an expression for the transfer gain of a feedback amplifier.	Understanding Applying	4
2	a) Differentiate between RC and LC type oscillators. b) Derive the expression for frequency of oscillation in a Hartley Oscillator. c) State Barkhausen Criterion for Oscillations	Understanding Applying	4
3	Starting from the description of a generalized oscillator, derive the expression for frequency of oscillation in a colpits oscillator	Understanding Applying	4
4	(a) Discuss about the types of negative feedback amplifiers giving the effect of each type of feedback on the parameters of the amplifier. (b) What sort of feedback is employed in a CE amplifier with by passed emitter resistor? Discuss its analysis in detail.	Understanding Applying	4
5	(a) What are the characteristics of an amplifier that are modified by negative feedback? (b) Draw the four types of feedback amplifiers naming them. (c) Define sensitivity & De sensitivity factors in feedback Amplifiers.	Understanding Applying	4

UNIT – V

Short Answer Questions

S.NO	Questions	Blooms Taxonomy Level	Course Outcome
1	What is an OP-AMP?	Understanding	5
2	What is Output Off Set Voltage?	Understanding	5
3	What is Input Off Set Current?	Understanding	5
4	What is slew rate?	Understanding	5
5	What is gain bandwidth product?	Understanding	5

Long Answer Questions:

S.N	Questions	Blooms	Course

O		Taxonomy Level	Outcome
1	Discuss in brief about the operation & characteristics of an OP-AMP.	Understanding	5
2	Discuss in brief about the operation & characteristics of Inverting Amplifier.	Understanding	5
3	Discuss in brief about the operation & characteristics of non inverting amplifier.	Understanding	5
4	Discuss in detail about Differentiator and Integrator.	Understanding	5
5	Discuss in detail about square wave and triangular wave generations.	Understanding	5

OBJECTIVE-TYPE QUESTIONS:

UNIT-I

Multiple choice questions:

1. Two different types of clippers are _____ and _____.

2. The figure of merit for diodes used in clipping circuit is _____.

3. The application of voltage comparator is _____.

4. The other name of clamping circuit is _____.

5. Clamping circuit theorem can be expressed as _____.

UNIT-II

Multiple choice questions:

1. The MOSFET stands for _____
   (A)Metal oxidized selenium FET (B).Metal oxide surface FET
   (C).Metal oxide semiconductor FET (D).Metal of surface FET
2. In MOSFETs N-channel is more preferred than P-channel because ____
   (A)It is cheaper (B)It is faster

   (C)It has better drive capability (D)It has better noise immunity

3. The main types of field effect transistor are _____
   (A)BJT and FET (B)UJT and FET _____

   (C)JFET and MOSFET (D)None of the above

4. The germanium transistors can be used upto ____
(A) 60^0C (B)100^0C (C)150^0C (D)300^0C

5. Transistor is a device which is a ____
(A)Transferring voltage device (B)Current operated one

(C) Power operated one (D)Voltage operated one

UNIT-III

Multiple choice questions:

1. In class B amplifiers relation between maximum power dissipation Pc and maximum output power dissipation Po is Pc= ____ Po [ ]

(a)0.1 (b)0.2 (c)0.3 (d)0.4

2. Due to input signal swing, if the operating point shifts into cutoff and saturation regions, that amplifier is classified as _____ amplifier. [ ]

(a)small signal (b)large signal (c)both a and b (d)not an amplifier

3. In ____ power amplifier, the output signal varies for a full 360^0 of the cycle. [ ]

(a)Class A (b) Class B (c) Class AB (d) None of the above

4. Maximum theoretical efficiency of Class B push pull amplifier is ___. [ ]

(a)25.5% (b) 50% (c) 75% (d) 78.5%

5. With transformer connection to load the maximum efficiency of the class A amplifier will go up to a maximum of [ ]

(a)78.5% (b) 25% (c) 50% (d) 66%

UNIT-IV

1. The amplifiers can be classified according to [ ]

(a)frequency range (b)inter stage coupling (c)operation method (d)all the above

2. If Z is the impedance connected between two nodes, node1 and node2, it can be replaced by two separate impedances Z1 and Z2, where Z1 is connected between node1 and

ground and Z2 is connected between node2 and ground. This is called ____theorem.
(a)Miller (b)Reciprocity (c)Superposition (d)Compensation

3. Which of the following amplifier has high power gain [ ]

(a) CB (b) CE (c) CC (d) both CB and CE

4. The slope of ac load line is _____ that of dc load line. [ ]

(a) same as (b)more than (c) less than (d) None of the above

5. The voltage gain of well designed single stage CB amplifier is essentially determined by ac collector load and [ ]

(a) Emitter resistor R_e (b)ac alpha (c) Input resistance emitter diode (d)ac beta.

6. Typical value of h_{ie} is [ ]

(a) 1k (b)25k (c) 50k (d) 100k

UNIT-V

1. A differential amplifier ……..
(a)is a part of an Op-amp (b)has one input and one output
(c)has two output (d)answers (1) and (2)

2. The output of a particular Op-amp increases 8V in 12μs. The slew rate is …….

(a)90 V/μs (b)0.67 V/μs (c)1.5 V/μs (d)none of these

3. The use of negative feedback ……
(a) reduces the voltage gain of an Op-amp (b)makes the Op-amp oscillate

(c) makes linear operation possible (d)answers (1) and (2)

4. A certain noninverting amplifier has R_i of 1 kΩ and R_f of 100 kΩ. The closed loop gain. .

(a)100,000 (b)1000 (c)101 (d)100

5. If the feedback resistor in Q15 (above question) is open, the voltage gain …….
(a)Increases (b)decreases (c)is not affected (d)depends on R_i

Websites:

1.http://www.onsemi.com/
2.http://www.kpsec.freeuk.com/symbol.htm
3.http://buildinggadgets.com/index_circuitlinks.htm
4.http://www.guidecircuit.com/
5.www.tina.com

JOURNALS:

1.IEEE Transaction on Electronic Circuit Analysis (ISSN**:** 0018-9383)
2.Journal of Active and Passive Electronic Devices (ISSN: 1555-0281)
3.International Journal of Micro and Nano Electronics, Circuits and Systems (*ISSN: 0975-4768)*
4.Active and Passive Electronic Components (ISSN: 0882-7516)
5.Journal of Electronic Testing (ISSN: 0923-8174)

LIST OF TOPICS FOR STUDENT SEMINARS:

1.Innovative Techniques Used in Single Stage & Multi Stage Amplifiers.
2.To study the Frequency Response of BJT Amplifiers.
3.Thermal runaway, thermal stability.
4.Design of CE, CC & CB amplifiers.
5.MOSFET Characteristics in Enhancement and Depletion Mode.
6.Working principle and VI characteristics of UJT.
7.Principle of operation of Schottky barrier diode.
8.Bias compensation using diodes and transistors.
9.Construction and principal of operation of FET.
10.Study of MOS Amplifiers.
11. Basic Concepts of Feedback Amplifiers.
12.Basic Concepts of Oscillators and its applications.
13. Basic Concepts of Large Signal Amplifiers and its applications,
14. Basic Concepts of Tuned Amplifiers and its applications.

SMALL PROJECTS:

1. Bread board wiring and testing of various types of Amplifiers.
2. Design and testing of MOS amplifiers
3. Design and testing of Feedback Amplifiers.
4. Design and testing of Small and Large Signal Amplifiers.
5. Design and testing of different types of Oscillators.

==== END ====