Government of Karnataka
Department of Technical Education
Board of Technical Examinations, Bengaluru

Course Title:	**ANALOG ELECTRONICS**	Course Code	: 15EE33T
Semester	: **III**	Course Group	: **Core**
Teaching Scheme (L:T:P)	:**4:0:0** (in Hours)	Credits	: **4 Credits**
Type of course	:**Lecture +Assignments**	Total Contact Hours	: **52**
CIE	: **25 Marks**	SEE	: **100 Marks**
Programme: Diploma in Electrical and Electronics Engg.			

Pre-requisites	**:** Science and Mathematics in Secondary Education, knowledge of Basics of Electrical Engg.
Course Objectives	**:** To introduce the concept of semiconductors and devices along with applications, power supply components, amplifiers, oscillators, timers and OP-AMP circuits

COURSE TOPICS:

Unit No	Unit Name	Hours
1	Semiconductors and Diodes	7
2	Transistors and MOSFETs	12
3	Optoelectronic devices	6
4	Rectifiers, filters and regulators	7
5	Amplifiers and Oscillators	11
6	OP-AMP and Timers	9
	Total	**52**

Course Outcomes:

On successful completion of the course, the student will be able to:

1. Understand the basics of semiconductors and Diodes
2. Explain Transistors and MOSFETs.

3. Analyse Optoelectronic devices
4. Analyse working of Rectifiers, filters, and regulators circuits
5. Classify and analyse Amplifiers and Oscillators circuits
6. Illustrate OP-AMP circuits and 555 Timer applications.

Composition of Educational Components

Questions for CIE and SEE will be designed to evaluate the various educational components (Bloom's Taxonomy) such as:

Sl. No.	Educational Component	Weightage (%)	Total Marks (Out of 145)
1	Remembering	10	15
2	Understanding	48	70
3	Application/ Analysis	42	60
Total		**100**	**145**

Course Outcome linkage to Cognitive Level

Cognitive Level Legend: R- Remember, U- Understand, A- Application

Course Outcome		CL	Linked PO	Teaching Hrs
CO1	Understand the basics of semiconductors and Diodes	***R/U***	2, 10	7
CO2	Explain Transistors and MOSFETs.	***U/A***	2, 10	12
CO3	Analyse Optoelectronic devices	***R/U***	2, 10	6
CO4	Analyse working of Rectifiers, filters, and regulators circuits	***U/A***	2,10	7
C05	Classify and analyse Amplifiers and Oscillators circuits	***U/A***	2, 10	11
C06	Illustrate OP-AMP circuits and 555 Timer applications.	***R/U/A***	2, 10	9
		Total sessions		**52**

Course Content and Blue Print of Marks for SEE:

Unit No	Unit Name	Hour	Max. Marks per Unit	Questions to be set for (5marks) PART - A			Questions to be set for (10marks) PART - B			Marks weightage (%)
				R	U	A	R	U	A	
1	Semiconductors and Diodes	7	**20**	**1**				**1**	**0.5**	14
2	Transistors and MOSFETs	12	**35**		**1**	**1**		**1.5**	**1**	24
3	Optoelectronic devices	6	**15**	**1**				**1**		10
4	Rectifiers, filters and regulators	7	**20**		**1**			**0.5**	**1**	14
5	Amplifiers and Oscillators	11	**30**		**1**	**1**		**1**	**1**	21
6	OP-AMP and Timers	9	**25**	**1**		**1**		**0.5**	**1**	17
	Total	**52**	**145**	**9 (45 Marks)**			**10 (100 Marks)**			**100**

Course-PO Attainment Matrix

Course	Programme Outcomes									
	1	2	3	4	5	6	7	8	9	10
Analog Electronics	-	**3**	-	-	-	-	-	-	-	**3**

Level 3- Highly Addressed, Level 2-Moderately Addressed, Level 1-Low Addressed.

Method is to relate the level of PO with the number of hours devoted to the COs which address the given PO.

If ≥40% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 3

If 25 to 40% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 2

If 5 to 25% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 1

If < 5% of classroom sessions addressing a particular PO, it is considered that PO is considered not-addressed.

Course Content:

Unit –I

Semiconductors and Diodes: Electrons- free and valence. Conductors, Insulators, and Semiconductors- definition &energy band diagrams.Properties of semiconductors.Meaning of Hole current, electron-hole pairs, recombination, doping, acceptor and donor impurities. Intrinsic and Extrinsic, N and P type semiconductors. Diode- formation, depletion region, VI Characteristics, ratings, types and applications. Zener diode- reverse bias characteristics, voltage regulation, shunt voltage regulator, and applications. Varistor and Thermistor- working and applications.

Unit –II

Transistors and MOSFETs: Transistors- definition, terminals, types, symbols, formation of NPN and PNP, ratings. Transistor biasing- definition, importance, list types,stabilisation, thermal runaway, heat sink, and voltage divider method. List configurations and applications.Alpha and Beta- definitions, relation.CE input and output characteristics- cut off, saturation, and active regions. Transistor as a switch.List applications. FET- definition, types. MOSFET- definition, types, symbols. N type enhancement mode- construction, working, characteristics, switch. List applications and ratings. Differentiate BJT and MOSFET.

Unit –III

Optoelectronic devices: Electron emission– types, applications. Symbols, working and applications of–photo diode, opto isolator, photo voltaic cell, LED, LDR, LCD, opto coupler.

Unit –IV

Rectifiers, filters and regulators: Regulated power supply- block diagram and applications. Rectifiers- definition, half wave, centre tapped and bridge full wave rectifier, efficiency, ripple factor, PIV, ratings.Filters- definition, necessity, C and PI filters, Regulator-definition, working of 7805, operating voltages- 7809, 7812, 7905, 7912.

Unit –V

Amplifiers and Oscillators: Amplifier- definition, faithful amplification, classificationbased on configuration,power, and frequency. Transistor CE amplifier with biasing.Working of class A, B, C, and Push pull amplifier. Two stage RC coupled amplifier- working, gain in dB, frequency response.Feed back- definition,types, advantages and disadvantages, applications. Oscillators- definition, classification, LC tank circuit, criteria.RC phase shiftand crystal oscillator- working, applications.CRT- construction, working and applications.

Unit –VI

OP-AMP and Timers: OPAMP– definition, block diagram, operation, characteristics, applications, µA 741 pin diagram. Definitions of virtual ground, CMRR and Slew rate.OPAMP applications– inverting, integrator, differentiator, summer, voltage follower, and comparator.Filters- definition, Working- low pass, high pass passive and active filters,applications.Timers– block diagram, pin diagram of 555, duty cycle, time constant, applications. Multi-vibrators- Astable and monostable using 555.

Reference Books:

1. Electronics Principles and applications by Charles A Schuler and Roger L Tokhiem, Sixth Edition, Mc. Graw Hill , 2008.
2. Electronics Principles by Malvino, Mc. Graw Hill, Third edition. 2000.
3. Electronics Devices and Circuits by AllanMottershed, PHI Learning Pvt. Ltd., First Edition.
4. Electronics Analog and Digital by I. J. Nagrath, PHI Learning Pvt. Ltd., 2013 Edition.
5. Linear Integrated Circuits by Ramakant A. Gayakwad, PHI Learning Pvt. Ltd., Fourth Edition.

e-Resources:

1. www.faculty.virginia.edu/stt/...5.../pdfFiles/SemiconductorsDiodes.pdf
2. www.youtube.com/watch?v=xzVDMUMW9JU
3. *https://en.wikipedia.org/wiki/*

Course Delivery:

The Course will be delivered through lectures, classroom interaction, animations, group discussion, exercises and student activities, assignments.

Course Assessment and Evaluation:

	What		To Whom	Frequency	Max Marks	Evidence Collected	Course Outcomes
Direct Assessment	**CIE (Continuous Internal Evaluation)**	I A Tests	Students	Three IA tests for Theory: (Average marks of Three Tests to be computed).	20	Blue Books	1 to 6
		Student Activity		Student Activity	05	Report of 2 pages	1 to 6
				TOTAL	**25**		
	SEE (Semester End Examination)	End Exam	Students	End Of the Course	100	Answer Scripts at BTE	1 to 6
Indirect Assessment	Student Feedback on course		Students	Middle Of The Course	Feed Back Forms		1 to 6
	End Of Course Survey			End Of The Course	Questionnaires		1 to 6

*__CIE__ – Continuous Internal Evaluation *__SEE__ – Semester End Examination

Note: I.A. test shall be conducted for 20 marks. Average marks of three tests shall be rounded off to the next higher digit.

Course Contents with Lecture Schedule:

Lesson No./ Session No.	Contents	Duration
Unit I	**Semiconductors and Diodes**	**7 Hours**
1.	Conductors, Insulators, and Semiconductors- definition & energy band diagrams.	01 Hour
2.	Properties of semiconductors. Meaning of Hole current, electron-hole pairs, recombination, doping, acceptor and donor impurities.	01 Hour
3.	Diode- formation, depletion region,	01 Hour
4.	VI Characteristics, Diode types, ratings and applications.	01 Hour
5.	Zener diode- reverse bias characteristics,	01 Hour
6.	Regulation, shunt voltage regulator, and applications.	01 Hour
7.	Working and applications of Varistor and Thermistor	01 Hour
Unit II	**Transistors and MOSFETs**	**12 Hr**
8.	Transistors- definition, terminals, types, symbols .	01 Hour
9.	Formation of NPN and PNP, ratings	01 Hour
10.	Transistor biasing- definition, importance, list types	01 Hour
11.	Stabilisation, thermal runaway, heat sink, and voltage divider bias method.	01 Hour
12.	List configurations and applications. Alpha and Beta- definitions, relation.	01 Hour
13.	CE input and output characteristics- cut off, saturation, and active regions	01 Hour
14.	Transistor as a switch in CE mode. List applications	01 Hour
15.	FET- definition, types. MOSFET- definition, types, symbols.	01 Hour
16.	N type enhancement mode- construction, working,	01 Hour
17.	MOSFET characteristics.	01 Hour
18.	MOSFET as switch, List applications and ratings	01 Hour
19.	Differentiate BJT and MOSFET.	01 Hour

Unit III	Optoelectronic devices	6 Hr
20.	Electron emission– types, applications,	01 Hour
21.	Symbols, working and applications of– photo diode, opto isolator	01 Hour
22.	Symbols, working and applications of photo voltaic cell,	01 Hour
23.	Symbols, working and applications of LED, LDR	01 Hour
24.	Symbols, working and applications of LCD.	01 Hour
25.	Symbols, working and applications of Opto coupler	01 Hour
Unit IV	**Rectifiers, filters and regulators**	**7 Hours**
26.	Regulated power supply- block diagram and applications.	01 Hour
27.	Rectifiers- definition, half wave, centre tapped FWR, efficiency, ripple factor, PIV	01 Hour
28.	Centre tapped FWR, efficiency, ripple factor, PIV	01 Hour
29.	Bridge full wave rectifier, efficiency, ripple factor, PIV, ratings	01 Hour
30.	Filters- definition, necessity	01 Hour
31.	C and PI filters	01 Hour
32.	Regulator-definition, working of 7805, mention operating voltages of 7809, 7812, 7905, 7912.	01 Hour
Unit V	**Amplifiers and Oscillators**	**11 Hr**
33.	Amplifier- definition, faithful amplification, classification based on configuration, power, and frequency.	01 Hour
34.	Transistor CE amplifier with biasing	01 Hour
35.	Working of Class A, B, C amplifier	01 Hour
36.	Working of Push pull amplifier.	01 Hour
37.	Two stage RC coupled amplifier- working, gain in dB, frequency response.	01 Hour
38.	Feed back- definition, positive and negative with block diagrams and applications.	01 Hour
39.	Oscillators- definition, classification	01 Hour

40.	LC tank circuit, criteria	01 Hour
41.	RC phase shift oscillator- working and applications	01 Hour
42.	Crystal oscillator- working and applications	01 Hour
43.	CRT- construction, working and applications.	01 Hour
Unit VI	**OPAMP and Timers**	**9 Hr**
44.	OPAMP– definition, block diagram, operation.	01 Hour
45.	Characteristics, applications, µA 741 pin diagram.	01 Hour
46.	Definitions of virtual ground, CMRR and Slew rate.	01 Hour
47.	OPAMP applications– inverting, differentiator	01 Hour
48.	Integrator, summer, voltage follower, and comparator.	01 Hour
49.	Filters- definition, working- low pass, high pass passive filters	01 Hour
50.	Working of low pass, high pass active filters, applications.	01 Hour
51.	Timer– block diagram, pin diagram of 555, duty cycle, time constant, applications	01 Hour
52.	Astable and monostable multi-vibrators using 555.	01 Hour

Student Activity (any one to be submitted with 3 pages self HAND WRITTEN report):

1. Study and identify the components of a serviceable regulated power supply.
2. Study/ rig up the amplifier circuit with loud speaker and test.
3. Visit nearby electronics shop/ market and identify the different diodes and ratings.
4. Visit nearby electronics shop/ market and identify the different Transistors and MOSFETs with their ratings.
5. Visit nearby Automobile show room and identify the optoelectronic devices and purpose.
6. Visit the nearby electronic shop/ market and list different IC's for timers and OP-AMP applications.

MODEL OF RUBRICS / CRITERIA FOR ASSESSING STUDENT ACTIVITY (Course Coordinator)

Dimension	Scale					Students score (Group of five students)				
	1 Unsatisfactory	2 Developing	3 Satisfactory	4 Good	5 Exemplary	1	2	3	4	5
1	Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	3				
2	Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2				
3	Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	5				
4	Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	4				
Note: Concerned faculty (Course coordinator) must devise appropriate rubrics/criteria for assessing Student activity for 5 marks **One activity on any one CO (course outcome) may be given to a group of FIVE students** **Grand Average/Total**						14/4 =3.5 ≈4				

Example only: MODEL OF RUBRICS / CRITERIA FOR ASSESSING STUDENT ACTIVITY-
Task given- Industrial visit and report writing

Dimension	Scale					Students score (Five students)				
	1 Unsatisfactory	2 Developing	3 Satisfactory	4 Good	5 Exemplary	1	2	3	4	5
1.Organisation	Has not included relevant info	Has included few relevant info	Has included some relevant info	Has included many relevant info	Has included all relevant info needed	3				
2. Fulfill team's roles & duties	Does not perform any duties assigned	Performs very little duties	Performs partial duties	Performs nearly all duties	Performs all duties of assigned team roles	2				
3.Conclusion	Poor	Less Effective	Partially effective	Summarises but not exact.	Most Effective	5				
4.Conversions	Frequent Error	More Error	Some Error	Occasional Error	No Error	4				
					Total marks	14/4=3.5 ≈4				

FORMAT OF I A TEST QUESTION PAPER (CIE)

Test/Date and Time	Semester/year	Course/Course Code	Max Marks
Ex: I test/6 th weak of sem 10-11 Am	I/II SEM		20
	Year:		

Name of Course coordinator :
Units:__ CO's:____

Question no	Question	MARKS	CL	CO	PO
1					
2					
3					
4					

Note: Internal Choice may be given in each CO at the same cognitive level (CL).

MODEL QUESTION PAPER (CIE)

Test/Date and Time	Semester/year	Course/Course Code	Max Marks
1st Test/ 6 th week, 9 Feb 16, 10-11 AM	III SEM, E & E Engg	**Analog Electronics**	20
	Year: 2015-16	Course code:	

Name of Course coordinator :
Units Covered :1 and 2
Course Outcomes : 1 and 2
Instruction :*(1). Answer all questions (2). Each question carries five marks*

Question No.	Question	CL	CO	PO
1	Define hole current, electron-hole pairs, and recombination	R	1	2, 10
2	List the applications of Varistor and Thermistor. OR Differentiate conductors, insulators, and semiconductors with energy band diagrams.	R U	1	2, 10
3	Define transistor biasing and its necessity. Also, list the types. OR Explain the formation of NPN and PNP Transistors.	U U	2	2, 10
4	Explain the working of MOSFET.	A	2	2, 10

CL: Cognitive Level, R-Remember, U-Understand, A-Application, PO: Program Outcomes

Model QUESTION Paper BANK:

Course Title: **ANALOG ELECTRONICS**	Course Code: 15EE33T

Unit 1 -Semiconductors and Diodes

Cognitive Level: REMEMBER

1) Define conductors, insulators, semiconductors with examples.
2) List the properties of semiconductors.
3) Define hole current, electron-hole pairs, and recombination,
4) Definedoping, acceptor and donor impurities.
5) Define diode and explain depletion region in PN junction.
6) List the types of diodes with their applications and ratings.
7) Define Zener diode and list the applications.
8) List the applications of Varistor and Thermistor.
9) Define regulation and explain the working of Zener voltage regulator.

Cognitive Level: UNDERSTAND

10) Explain briefly the energy band digramsof conductors, insulators, andsemiconductors.
11) Differentiate conductors, insulators, and semiconductors.
12) Differentiate conductors, insulators, and semiconductors with energy band diagrams.
13) Differentiate Intrinsic and Extrinsic semiconductors.
14) Explain P and N type semiconductors with covalent bond diagram.
15) Explain the forward and reverse bias characteristics of diode.
16) Expalin the VI charactersistics of diode.
17) Explain the reverse bias charactersistics of Zener diode.
18) Explain the working of Varistor.
19) Explain the working of Thermistor.

Unit 2 - Transistors and MOSFETs

Cognitive Level: UNDERSTAND

20) Define Transistor and mention the function of each terminal.
21) List the types of transistors with their symbols.
22) List the ratings and applications of Transistors.
23) Define transistor biasing and its necessity. Also, list the types.
24) Define stabilisation, thermal runaway and heat sink.
25) List the Transistor configurations with their applications.

26) Define Alpha and Beta.
27) List the types of FETs.
28) List the MOSFET ratings and applications.
29) Explain the formation of NPN and PNP Transistors.

Cognitive Level: APPLICATION

30) Explain the working of NPN Transistor.
31) Explain the voltage divider method of biasing.
32) Derive the relation between Alpha and Beta.
33) Explain the Transistor CE characteristics.
34) Sketch Transistor characteristics to show cut off, saturation, and active regions.
35) Briefly explain cut off, saturation, and active regions.
36) Explain Transistor as a switch.
37) Explain the construction of MOSFET.
38) Explain the working of MOSFET.
39) Sketch and explain the MOSFET characteristics.
40) Explain MOSFET as a switch.
41) Differentiate BJT and MOSFET.

Unit 3 -Optoelectronic devices

Cognitive Level: REMEMBER

42) Define Electron emission.
43) List the types of electron emission with their applications.
44) List the applications of different optoelectronic devices.

Cognitive Level: UNDERSTAND

45) Sketch the symbols of different optoelectronic devices.
46) Explain the working of photo diode.
47) Explain the working of opto-isolator.
48) Explain the working of photo voltaic cell.
49) Explain the working of LED.
50) Describe the working of LDR.
51) Explain the working of LCD.
52) Describe the working of opto-coupler.

Unit 4 - Rectifiers, filters and regulators

Cognitive Level: UNDERSTAND

53) Sketch the block diagram of Regulated power supply and list the components.
54) List the applications of Regulated power supply.
55) Define Rectifier and list the applications.
56) Define rectifier efficiency, ripple factor and PIV.
57) List the values for efficiency, ripple factor, and diode PIV for different rectifiers.
58) Define filter and its necessity.
59) Define voltage regulator and list the operating voltages of 78XX and 79XX series.

Cognitive Level: APPLICATION

60) Explain working of half wave rectifier
61) Explain the working of full wave centre tapped rectifier.
62) Explain the working of full wave bridge rectifier.
63) Describe the working of C filter.
64) Describe the working of PI filter.
65) Sketch and explain the working of 7805 voltage regulator.

Unit 5 - Amplifiers and Oscillators

Cognitive Level: UNDERSTAND

66) Define Amplifier and give the classification of amplifiers.
67) Define faithful amplification.
68) Describe the working of Transistor CE amplifier.
69) Define gain in dB and frequency response.
70) Define feedback and list the types with their applications.
71) List the advantages and disadvantages of negative feed back.
72) Define oscillator.
73) Classify the the different types of oscillators.
74) List the applications of oscillators.
75) Describe the construction of CRT.
76) List the applications of CRT.

Cognitive Level: APPLICATION

77) Explain the working of class A amplifier.
78) Explain the working of class B amplifier.
79) Explain the working of class C amplifier.
80) Explain the working of push pull amplifier.
81) Explain the working of two stage RC coupled amplifier.

82) Explain briefly positive and negative feed back.
83) Explain Bark hauvsen criteria for obtaining oscillation.
84) ExplainLC tank oscillation circuit.
85) Explain the working of RC phase shift oscillator.
86) Explain the working of crystal oscillator.
87) Explain the working of CRT.

Unit 6 - OPAMP and Timers

Cognitive Level: REMEMBER

88) Define OPAMP. List the applications.
89) List the characteristics of Op-AMP.
90) Define virtual ground, CMRR and Slew rate.
91) Define passive and active filters.
92) Define low pass and high pass filters.
93) Define Timer and sketch the block diagram.
94) Define time constant and duty cycle.
95) List the applications of 555 Timer.
96) Define multi-vibrator. List the types.

Cognitive Level: UNDERSTAND

97) Sketch and explain the block diagram of OP-AMP.
98) Sketch the pin diagram of µA 741 and label the terminals.
99) Sketch and explain Voltage follower and comparator circuits.
100) Sketch the pin diagram of 555 timer and label them.
101) List the applications of filters.

Cognitive Level: APPLICATION

102) Describe Op-Amp as Inverting amplifier.
103) Describe Op-Amp integrator circuit.
104) Explain Op-Amp differentiator circuit.
105) Explain Op-Amp as summer.
106) Explain the working passive low pass and high pass filters.
107) Explain the working active low pass and high pass filters.
108) Explain 555timer as astable multi-vibrator.
109) Explain 555 timeras monostable multi-vibrator.

Model Question Paper:

Code:15EE33T

ANALOG ELECTRONICS

III Semester Examination

Diploma in Electrical and Electronics Engg.

Time: 3 Hours

Max Marks: 100

***Note*:** i) Answer any SIX questions from PART - A. Each question caries 5 marks.

ii) Answer any SEVEN Questions from PART - B. Each question caries 10 marks.

PART – A

1) Differentiate conductors, insulators, and semiconductors.
2) Explain the working of NPN Transistor.
3) Explain the working of photo voltaic cell.
4) Define rectifier efficiency, ripple factor and PIV.
5) Classify the the different types of oscillators.
6) Define Timer and sketch the block diagram.
7) Differentiate BJT and MOSFET.
8) Describe the construction of CRT.
9) List the characteristics of Op-AMP.

PART – B

10)	(a)	Explain P and N type semiconductors with covalent bond diagram.	(7 M)
	(b)	List the applications of Varistor and Thermistor.	(3 M)
11)	(a)	Explain the forward and reverse bias characteristics of diode.	(5 M)
	(b)	Define Alpha and Beta.	(5 M)
12)	(a)	Define transistor biasing and its necessity. List the types.	(6 M)
	(b)	List the MOSFET ratings and applications.	(4 M)
13)	(a)	Explain the Transistor CE characteristics.	(7 M)
	(b)	Sketch the construction diagram of MOSFET and label.	(3 M)
14)	(a)	List the types of electron emission with their applications.	(4 M)
	(b)	Explain the working of opto-coupler.	(6 M)
15)	(a)	Explain the working of full wave bridge rectifier.	(6 M)
	(b)	Describe the working of PI filter.	(4 M)
16)	(a)	Sketch and explain the working of 7805 voltage regulator.	(7 M)
	(b)	Define Amplifier and give the classification of amplifiers.	(3 M)
17)	(a)	Explain the working of push pull amplifier.	(7 M)
(b)		Define oscillator. Classify the different types of oscillators.	(3 M)

18) (a)	Explain the working of crystal oscillator.	(5 M)
(b)	Describe Op-Amp integrator circuit.	(5 M)
19) (a)	Define passive and active filters.	(3 M)
(b)	Explain 555 timeras astable multi-vibrator.	(7 M)

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