Program Name : **Diploma in Electrionics Program Group**

Program Code : **DE/EE/EJ/IE/IS/MU/ET/EN/EX**

Semester : **Second**

Course Title : **Basic Electronics**

Course Code : **22216**

1. RATIONALE

Diploma engineers have to deal with the various electronic components while maintaining various electronics equipment. The study of basic operating principles and handling of various electronics devices will help them to troubleshoot electronics equipment. This course is developed in such a way that, students will be able to apply the knowledge to solve broad electronic engineering application problems.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Maintain electronic circuits comprising of discrete electronic components.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following ***industry oriented*** COs associated with the above mentioned competency:

a. Use relevant diode in different electronics circuits.
b. Maintain rectifiers comprising of diodes.
c. Use BJT in electronics circuits.
d. Use FET in electronics circuits.
e. Maintain DC regulated power supply.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory						Practical					
				Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
L	T	P			Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
4	-	4	8	3	70	28	30*	00	100	40	50#	20	50	20	100	40

(*):Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **ESE** - End Semester Examination; **PA** - Progressive Assessment*

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

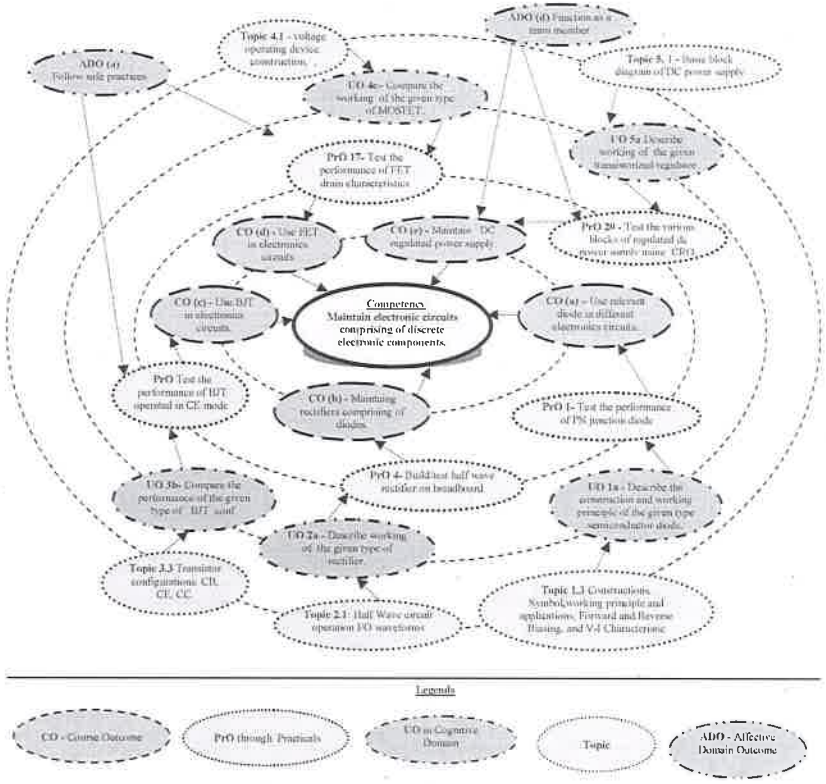

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency.

S. No.	Practical Outcomes(PrOs)	Unit No.	Approx. Hrs. Required
1	Test the performance of PN junction diode .	I	2*
2	Test the performance of zener diode.	I	2
3	Test the performance of photo diode by varying the light intensity as well as distance of the light source.	I	2

S. No.	Practical Outcomes(PrOs)	Unit No.	Approx. Hrs. Required
4	Build/test half wave rectifier on breadboard	II	2
5	Build/test half wave rectifier on breadboard with filter- Part I	II	2*
6	Build/test half wave rectifier on breadboard with filter- Part II	II	2
7	Build/ test full wave rectifier on breadboard using two diodes.	II	2*
8	Build/ test full wave rectifier on breadboard using two diodes.	II	2
9	Build/ test full wave bridge rectifier on breadboard .	II	2
10	Use LC filter with fullwave rectifier to measure ripple factor.	II	2
11	Use π filter with bridge rectifier to measure ripple factor.	II	2
12	Assemble positive clipper circuit on breadboard and test the performancs.	II	2
13	Assemble Negative clipper circuit on breadboard and and test the performancs.	II	2
14	Build the combinational Clipper on breadboard and test the performance. - Part I	II	2*
15	Build the combinational Clipper on breadboard and test the performance. - Part II	II	2
16	Build positive clamper on breadboard and test the performance. - Part I	II	2
17	Build positive clamper on breadboard and test the performance. - Part II	II	2
18	Build Negative clamper on breadboard test the performance.	II	2
19	Identify the terminals of the PNP and NPN transistor using different methods . - Part I	III	2*
20	Identify the terminals of the PNP and NPN transistor using different methods . - Part II	III	2
21	Find specifications of a given transistor using data sheets.	III	2
22	Test the performance of BJT working in CE mode .	III	2
23	Test the performance of BJT working in CB mode .	III	2
24	Test the assembled BJT voltage divider bias circuit for given input. - Part I	III	2
25	Test the assembled BJT voltage divider bias circuit for given input. - Part II	III	2
26	Test the performance of FET drain characteristics , transfer characteristics and calculate trans-conductance. - Part I	IV	2*
27	Test the performance of FET drain characteristics , transfer characteristics and calculate trans-conductance. - Part II	IV	2
28	Build / test zener voltage regulator for the given voltage.	V	2
29	Test the performance of transistorized series voltage regulator for the given load regulation.	V	2
30	Test the performance of transistorized shunt voltage regulator for the given load regulation	V	2
31	Test the various blocks of regulated dc power supply .	V	2
32	Find out faults at different stages of regulated dc power supply.	V	2
33	Trouble shoot given DC regulated power supply. - Part I	V	2*
34	Trouble shoot given DC regulated power supply. - Part II	V	2
	Total		**68**

Note

*i. A suggestive list of **PrOs** is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:

S. No.	Performance Indicators	Weightage in %
1	Preparation of experimental set up	20
2	Setting and operation	20
3	Safety measures	10
4	Observations and Recording	10
5	Interpretation of result and Conclusion	20
6	Answer to sample questions	10
7	Submission of report in time	10
	Total	**100**

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a. Follow safety practices.
b. Practice good housekeeping.
c. Demonstrate working as a leader/a team member.
d. Maintain tools and equipment.
e. Follow ethical practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year.
- 'Organising Level' in 2nd year.
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	Exp. S. No.
1	Variable DC power supply 0- 30V, 2A, SC protection, display for voltage and current.	1,2,3,9,10, 12,13,15, 16,17,18, 19,20 21
2	Cathode Ray Oscilloscope Duel Trace 20Mhz, 1MegaΩ Input Impedance	4,5,6,7,8,9,10,11,12, 13,14, 22
3	Function Generator 0-2 MHz with Sine , square and triangular output with variable frequency and amplitude.	4,5,6,7,8,9,10,11,12, 13
4	Digital Multimeter : 3 1/2 digit display, 9999 counts digital	All

S. No.	Equipment Name with Broad Specifications	Exp. S. No.
	multimeter measures: V_{ac}, V_{dc} (1000V max) , A_{dc}, A_{ac} (10 amp max), Resistance (0 - 100 MΩ) , Capacitance and Temperature measurement	
5	Lux meter 3000 Lumen, Battery operated hand held type	3
6	Electronic Work Bench : Bread Board 840 -1000 contact points: Positive and Negative power rails on opposite side of the board , 0-30 V, 2 Amp Variable DC power supply, Function Generator 0-2MHz, CRO: 0-30 MHz, Digital Multimeter	All

8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics is to be taught and assessed in order to develop UOs for achieving the COs to attain the identified competency:

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Semiconductor Diode	1a. Describe the construction and working principle of the given type semiconductor diode. 1b. Differentiate between the given type of insulator, conductor and semiconductor based on energy band theory. 1c. Describe working principle, characteristics, and application of the given type of diode. 1d. Describe effect of temperature on the given type of diode.	1.1 Different types of Semiconductor Diodes and their materials 1.2 Energy band theory and effect of temperature 1.3 Construction, Symbol , working principle , applications, Forward and Reverse Biasing and V-I Characteristic of following diodes: PN junction, Zener, LED, Photo diode
Unit– II Applications of diodes	2a. Describe working of the given type of rectifier. 2b. Describe the need and working of the given type of rectifier filter circuit. 2c. Select clipper or clamper for obtaining the given waveform. 2d. Calculate ripple factor, PIV and efficiency of the given type of rectifier.	2.1 Types of Rectifiers: Half Wave, Full Wave Rectifier (bridge and center tapped): circuit operation I/O waveforms for voltage and current 2.2 Parameters of rectifier: Average DC value of current and voltage ripple factor ripple frequency PIV of diode, TUF, efficiency of rectifier 2.3 Types of Filters: Shunt capacitor, Series inductor, LC and π filter, bledder resistor 2.4 Clipper and Clamper circuits
Unit– III Bipolar Junction Transistor	3a. Describe the working principle of the given type of transistor. 3b. Compare the performance of the given type of transistor configurations. 3c. Justify the biasing method for the given circuit.	3.1 Current operating device 3.2 Different types of transistors: PNP, NPN 3.3 Transistor configurations: CB, CE, CC, Transistor characteristics (input, output,) in different transistor configurations

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	3d. Describe the procedure to minimize the thermal runaway effect for the given type of transistor baising circuit.	3.4 BJT biasing: DC load line, operating point, stabilization, thermal runaway, types of biasing, fixed biasing, base bias with emitter feedback, voltage divider
Unit– IV Field Effect Transistor	4a. Explain the working of FET for the given application. 4b. Explain the given type of FET biasing method. 4c. Compare the working of the given type of MOSFET. 4d. Differentiate the working principle of FET and MOSFET on the basis of the given transfer characteristic curve.	4.1 Voltage operating device Construction of JFET (N-channel and P- channel), symbol, working principle and characteristics (Drain and Transfer characteristics) 4.2 FET Biasing: Source self bias, drain to source bias 4.3 Applications of FET 4.4 MOSFET: Construction, working principle and characteristics of Enhancement and depletion MOSFET, MOSFET handling
Unit– V Regulators and power supply	5a. Describe working of the given transistorized regulator. 5b. Describe the working of the given block of the DC regulated power supply in the block diagram. 5c. Calculate output voltage of the given zener voltage regulator circuit. 5d. Calculate load and line regulation of the given transistorized regulator.	5.1 Basic block diagram of DC regulated power supply 5.2 Load and Line regulation 5.3 Zener diode voltage regulator 5.4 Transistorized series and shunt regulator - circuit diagram and working

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Semiconductor Diode	12	3	4	7	14
II	Applications of diodes	14	3	6	7	16
III	Bipolar Junction Transistor	16	3	7	8	18
IV	Field Effect Transistor	12	3	4	5	12
V	Regulators and power supply	10	2	3	5	10
Total		**64**	**14**	**24**	**32**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*

Note: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course:

a. Prepare journals based on practical performed in laboratory.
b. Test different diodes using CRO.
c. Give seminar on any relevant topic.
d. Library survey regarding different data books and manuals.
e. Prepare power point presentation for wave shaping circuits.
f. Undertake a market survey of different semiconductor components.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course :

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Guide student(s) in undertaking micro-projects.
f. Use PPTs to explain the construction and working of rectifier.
g. Use PPTs to explain the construction and working of wave shaping circuits.
h. Guide students for using data manuals.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student assigned to him/her in the beginning of the semester. S/he ought to submit it by the end of the semester to develop the industry oriented COs. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course.

In the first four semesters, the micro-project could be group-based. However, in higher semesters, it should be individually undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. A suggestive list is given here. Similar micro-projects could be added by the concerned faculty:

a. **Diode**: Build a circuit on general purpose PCB to clip a positive half cycle at 1.5 v or a waveform with input signal 5Vpp., and prepare the report.

b. **Diode:** Build a circuit on general purpose PCB to clamp a waveform at 3.0V using diode and passive components.
c. **FET**: Prepare chart on comparison of specifications of FETs using data sheets of at least three FET.
d. **FET**: Prepare a chart on FETs contains its symbol, advantages and applications.
e. **Rectifier**: Build a half wave rectifier for 6V, 500mA output current on general purpose PCB.
f. **Rectifier**: Build a full wave bridge rectifier with capacitor filter for 6V, 500mA output current on general purpose PCB.
g. **BJT:** Build a circuit to switch on and off the LED by using BJT as switching component.
h. **Photodiode:** Build a circuit on breadboard to turn the relay on and off by using photo diode and prepare a report.
i. **Voltage Regulator:** Build a circuit of DC regulated power supply on general purpose PCB for 9V and 500mA output.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Electronic Devices and Circuit: An Introduction	Mottershead, Allen	PHI Learning, New Delhi, ISBN : 9788120301245
2	Electronic Devices and Circuit Theory	Boylestead Robert, Louis Neshelsky	Pearson Education,10th edition, New Delhi,2009, ISBN: 978-8131727003
3	The Art of Electronics	Paul Horowitz Winfield Hill	Cambridge University Press, New Delhi 2015 ISBN: 9780521689175
4	Electronics Principles	Malvino, Albert Paul, David	McGraw Hill Eduction, New Delhi, ISBN: 978-0070634244
5	Principles of Electronics	Mehta, V.K. Mehta, Rohit	S. Chand and Company, Ram Nagar, New Delhi-110 055, 2014, ISBN: 9788121924504
6	Basic Electronic Engineering	Baru V., Kaduskar R.,Gaikwad S.T.	Dreamtech Press, New Delhi, 2015 ISBN: 9789350040126
7	Fundamentals of Electronic Devices and Circuits	Bell, David	Oxford University Press, International edition, USA, 2015, ISBN : 9780195425239
8	A text book of Applied Electronics	Sedha, R.S.	S.Chand ,New Delhi, 2008, ISBN: 978-8121927833

14. SOFTWARE/LEARNING WEBSITES

a. www.nptel.iitm.ac.in
b. www.datasheetcafe.com
c. www.williamson-labs.com
d. www.futurlec.com
e. www.bis.org.in
f. www.learnerstv.com
g. www.cadsoft.io
h. www.khanacademy.com

Program Name : **Diploma in Electronics and Telecommunication Engineering and Diploma in Digital Electronics**

Program Code : **EJ/DE/ET/EN/EX**

Semester : **Second**

Course Title : **Electronic Engineering Materials**

Course Code : **22217**

1. RATIONALE

'Electronic Engineering Materials' is the basic course for the Electronics and Communication engineering and Digital Electronics engineering student. Material science have undergone radical changes, especially due to requirement of electronic component in variety of application area.This subject will enable the student to know and apply facts, concepts and working principles for the selecting material and components for various electronics engineering applications.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Select electronic engineering materials for specified electronics application.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency.

a. Choose relevant metal on basis of conductivity property.
b. Interpret the properties of dielectric materials.
c. Select relevant magnetic materials for the specified electronics application.
d. Select relevant semiconductor device fabrication materials .
e. Select material for the relevant applications.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory						Practical					
				Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
L	T	P			Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	-	3	3	70	28	30*	00	100	40	--	--	--	--	--	--

(*): Under the theory PA; Out of 30 marks, 10 marks of theory PA is for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the UOs required for the attainment of the COs.

***Legends:** **L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **ESE** - End Semester Examination; **PA** - Progressive Assessment.*

5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

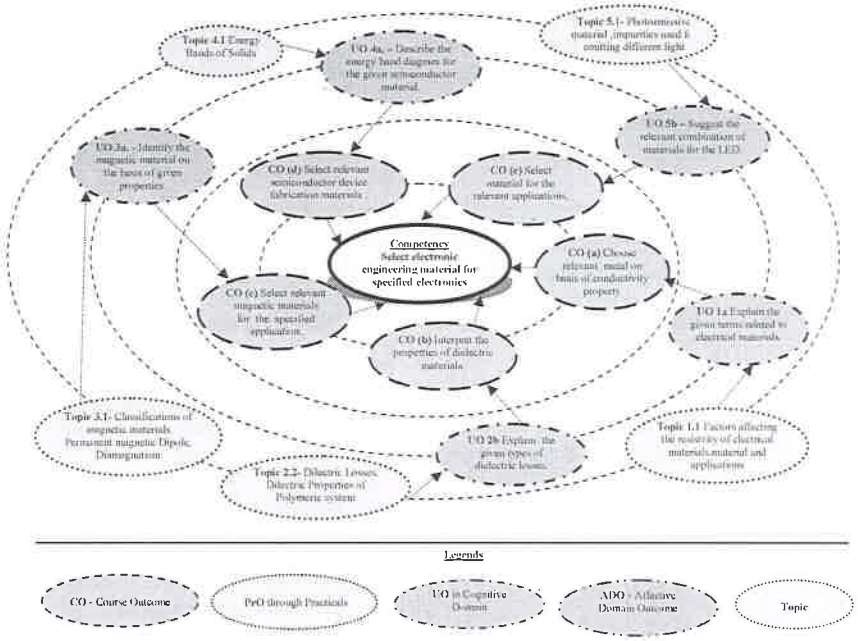

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

- Not applicable –

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

Not applicable –

8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics is to be taught and assessed in order to develop UOs for achieving the COs to attain the identified competency:

Unit	Unit Outcomes(UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Conductivity of Materials	1a. Explain the given terms related to electrical materials. 1b. Describe the effect on conductivity of metal on the basis of the given factor (s).	1.1 Terms and factors affecting the resistvity of electrical materials 1.2 Electron mobility, energy level diagram of a materials 1.3 Emission of electrons from metals

Unit	Unit Outcomes(UOs) (in cognitive domain)	Topics and Sub-topics
	1c. Expain the given mode(s) of electron emission from metals. 1d. Explain the effect of change in temperature on the conductivity of the given metal.	modes of emission – therminoic emission , photo electric emission , field emission , secondary emission , concept, material and applications 1.4 Effect of temperature on conductivity of metals, superconductivity , electrial and thermal conductivity of metals 1.5 Thermoelectric effect concept , material and applications
Unit-II Dielectric Materials	2a. Describe the effect on the capacitance on the given dielectric material on the basis of the given factor(s). 2b. Explain the given types of dielectric losses. 2c. Explain the concept of the given phenomenon of dilectric material.. 2d. Select the dielectric material for the given application.	2.1 Effect of dielectric on the behavior of capacitor , frequency dependence of electronic polarisability, frequency dependence of permittivity 2.2 Dilectric losses, dilectric properties of polymeric material 2.3 Insulating materials - breakdown in gaseous , liquid and solid delectric materials, requirements of good insulating materials 2.4 Dielectric materials –mica, porecilan , polythene , bakelite , polyvinylcarboide (PVC),rubber ,cotton and silk ,glass ,paper and Boards, wood, enamel covering, transformer oil, polymers properties and applications . 2.5 Ferroelectricity and piezoelectity concept , materials and applications
Unit– III Magnetic Properties of Materials	3a. Identify the magnetic material on the basis of given magnetic properties. 3b. Describe the given Hysterisis loop identifying the material. 3c. Describe the effect on permeability of the material due to the given factor (s). 3d. Explain the concept anti ferromagnetism.	3.1 Classifications of magnetic materials Permanent magnetic dipole, diamagnetism, paramagnetism, ferromagnetism ferromagntic domain 3.2 Magnetisation curve hysterisis loop magnetosteiction effect– application for ultrasonic generation, permeability and affecting factors 3.3 Magnetic material– iron and silicon iron alloy, nickel iron alloy, 3.4 Anti-ferromagnetism and ferrimagnetism
Unit– IV Semi Conductor Materials	4a. Describe the energy band diagram for the given semiconductor material. 4b. Select the material for given type of impurity add in semiconductor. 4c. Explain the given effect of	4.1 Energy bands of solids: conductors, semiconductors,nonconductors 4.2 Types of semiconductors, intrinsic material, impurity type and material for various impurities 4.3 Diffusion, hall effect,thermal and electrical conductivity of semi conductor

Unit	Unit Outcomes(UOs) (in cognitive domain)	Topics and Sub-topics
	semiconductor material and its application. 4d. Select the relevant material for the given semicoductor device fabrication with justification.	materials 4.4 Materials for fabrication of semiconductor devices – passive materials and process materials. substrate, metal, capacitance material. Junction coating , device pooting, Packaging
Unit –V Micro-electronic components and special materials	5a. Explain with sketches the working of the given type of LASER. 5b. Suggest the relevant combination of materials for the LED of the given wavelength. 5c. Suggest the relevant material for the given type of antenna. 5d. Identify the relevant micro-device for the given application and the material of which it is made of.	5.1 Photoemissive material, impurities used to emit different colours of light/ wavelengh; electroluminiscence and junction LASERS 5.2 Material for flexible and wearable antenas 5.3 Photovoltaic material 5.4 Materials used and application micro motors, micro relay and micro switches.

***Note**: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'.*

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Conductivity of Materials	10	06	06	06	18
II	Dielectric Materials	10	04	06	06	16
III	Magnetic Properties of Materials	10	04	06	06	16
IV	Semi Conductor Materials	10	04	04	04	12
V	Microc electronic components and special materials	08	02	02	04	08
Total		**48**	**20**	**24**	**26**	**70**

***Legends**: R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
***Note:** This specification table provides general guidelines to assist students for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related *co-curricular* activities which can be undertaken to accelerate the attainment of the various outcomes in this course:

a. Library / Internet survey of electrical /electronic material
b. Prepare power point presentation or animation for understanding different material behavior.
c. Access national digital Library for survey .

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Use Flash/Animations to explain various theorems in circuit analysis
f. Guide student(s) in undertaking micro-projects

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a group of 3-4 student assigned to them in the beginning of the semester. They ought to submit it by the end of the semester to develop the industry oriented COs. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** **during the course.**

In the first four semesters, the micro-project could be group-based. However, in higher semesters, it should be individually undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. A suggestive list is given here. Similar micro-projects could be added by the concerned faculty:

a. Prepare the chart of conducting materials
b. Prepare the chart of dielectric materials
c. Collect different samples of insulating material and prepare chart of their applications
d. Collect different samples of conducting material and prepare chart of their applications
e. Collect data for bifuel project erction
f. Make survey for PV cell as per efficiency and pricing.
g. Prepare chart for application of nanomateil
h. Demostrate effect of various modes of magnetism.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	An Introduction to	C S Indulkar and S.	S Chand Publishing New Delhi

S. No.	Title of Book	Author	Publication
	Electrical Materials by	Thiruvengadam S	ISBN 9788121906661
2	A course in Electrical engineering Materials	S.P. Seth and P.V. Gupta	Dhanpat Rai and Sons.
3	Material Science and Engg.	William D. Callister	WILLEY India 2/e Edition ISBN 9788126541607

14. SOFTWARE/LEARNING WEBSITES

a. https://www.youtube.com/watch?v=ooLJ_bGKmH
b. https://www.youtube.com/watch?v=emCqQdrSo3o
c. http://www.engineeringtoolbox.com/thermal-conductivity-metals-d_858.html


MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION MUMBAI