

# COMPETENCY BASED CURRICULUM

## DIPLOMA IN ELECTRICAL ENGINEERING (Duration 03 Years) NSQF Level – 4



Under  
Haryana State Board of Technical Education



Developed By  
Curriculum Development Center  
National Institute of Technical Teachers Training & Research  
(Ministry of Education, Government of India)  
Sector - 26, Chandigarh, UT, India.

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## 12. STUDY AND EVALUATION SCHEME

### THIRD SEMESTER

Sr. No.	SUBJECTS	STUDY SCHEME Periods/Week		Credits L+P= C	MARKS IN EVALUATION SCHEME						Total Marks of Internal & External
		INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT						
		L	P		Th	Pr	Total	Th	Pr	Total	
3.1	Industrial/In-HouseTraining - I	-	2	0+1 =1	-	40	40	-	60	60	100
3.2	Electric Machines –I	3	4	3+2=5	40	40	80	60	60	120	200
3.3	Electrical Measurement & Instrumentation	3	4	3+2=5	40	40	80	60	60	120	200
3.4	Analog & Digital Electronics	3	2	3+1=4	40	40	80	60	60	120	200
3.5	Electrical Engineering Materials	3	-	3+0=3	40	-	40	60	-	60	100
3.6	Open Elective (MOOCs <sup>+</sup> /Offline)	2	-	2+0=2	40	-	40	60	-	60	100
3.7	Electrical Engineering Drawing	-	6	0+3=3	-	40	40	-	60	60	100
# Student Centered Activities (SCA)		-	3	-	-	-	-	-	-	-	-
Total		14	21	23	200	200	400	300	300	600	1000

+ Assessment of Open Elective through MOOCs shall be based on assignments out of 100 marks.

# Student Centered Activities will comprise of co-curricular activities like extension lectures on Constitution of India, Electoral Literacy, Motor Vehicles (Driving) Regulations 2017 etc., games, hobby clubs e.g. photography etc., seminars, declamation contests, educational field visits, N.C.C., NSS, Cultural Activities and self-study etc.

**FOURTH SEMESTER**

Sr. No.	SUBJECTS	STUDY SCHEME		Credits (C) L + P = C	MARKS IN EVALUATION SCHEME						Total Marks of Internal & External
		Periods/Week			INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT			
		L	P		Th	Pr	Total	Th	Pr	Total	
4.1	*English and Communication Skills - II	2	2	2+1=3	40	40	80	60	60	120	200
4.2	Electric Machines -II	3	4	3+2=5	40	40	80	60	60	120	200
4.3	PLC & Microcontrollers	3	4	3+2=5	40	40	80	60	60	120	200
4.4	Estimating and Costing in Electrical Engineering	3	2	3+1=4	40	40	80	60	60	120	200
4.5	Utilization of Electrical Energy	3	-	3+0=3	40	-	40	60	-	60	100
4.6	Programming Skills	-	6	0+3=3	-	40	40	-	60	60	100
# Student Centered Activities (SCA)		-	3	-	-	-	-	-	-	-	-
Total		14	21	23	200	200	400	300	300	600	1000

\* Common with other diploma programmes

# Student Centered Activities will comprise of co-curricular activities like extension lectures on Constitution of India, Electoral Literacy, Motor Vehicles (Driving) Regulations 2017 etc., games, hobby clubs e.g. photography etc., seminars, declamation contests, educational field visits, N.C.C., NSS, Cultural Activities and self-study etc.

**Industrial/In-house Training:** After 4<sup>th</sup> Semester, students shall undergo Summer Training of 4 Weeks.

### 13. HORIZONTAL AND VERTICAL SUBJECTS ORGANISATION

Sr. No.	Subjects/Areas	Hours Per Week	
		Third Semester	Fourth Semester
1.	Industrial/In-House Training - I	2	-
2.	Electric Machines –I	7	-
3.	Electrical Measurement & Instrumentation	7	-
4.	Analog & Digital Electronics	5	-
5.	Electrical Engineering Materials	3	-
6.	Open Elective (MOOCs+/Offline)	2	-
7.	Electrical Engineering Drawing	6	-
8.	English and Communication Skills - II	-	4
9.	Electric Machines -II	-	7
10.	PLC & Microcontrollers	-	7
11.	Estimating and Costing in Electrical Engineering	-	5
12.	Utilization of Electrical Energy	-	3
13.	Programming Skills	-	6
14.	Student Centered Activities	3	3
<b>Total</b>		<b>35</b>	<b>35</b>

## 14. COMPETENCY PROFILE & EMPLOYMENT OPPORTUNITIES

Industry and government sector pertaining to **Electrical Engineering** require **skilled workers** to work in familiar, predictable, routine situations of clear choice. They should be able to communicate in writing and speaking with required clarity and fluency. Students after passing level 4 shall have understanding of basic arithmetic, algebraic principles along with basic understanding of social and natural environment. They are expected to recall and demonstrate quality skill in narrow range of applications using appropriate rules and tools. Students having the diploma in Electrical engineering experience and expansive skill set needed to design and operate electrical systems, such as circuitry, power station generators, flight systems, and computers.

Skilled workers will be responsible for carrying out a range of jobs, some of which will require them to make choices about the approaches they adopt. They will be expected to learn and improve their practice on the job. They should know what constitutes quality in the occupation and should distinguish between good and bad quality in the context of their job roles. Skilled worker at this level will be expected to carry out their work safely and securely and take full account of the health and safety on colleagues and customers. They should work hygienically and in ways which show an understanding of environmental issues. In working with others, they will be expected to conduct themselves in ways which show a basic understanding of the social and political environment.

NSQF Level – 4 pass out students are expected have need to have a strong understanding of electrical principles and safety standards. Electricians are responsible for installing and repairing electrical systems in buildings, homes, and other structures. This includes wiring, lighting, and other electrical components.

Overall, the job opportunities for diploma holders in electrical engineering are quite diverse, and employment can be found in a wide range of industries, including manufacturing, construction, telecommunications, and more. An electrical technician is responsible for installing, maintaining, and

repairing electrical equipment and systems.

Government Departments such as Electricity Board, MES, PWD, Railways, Air bases, Airports, Defence, Thermal, Hydro and Nuclear Power Stations and other Boards and Corporations: Construction, erection and commissioning of lines and Sub-stations, Electrical Safety measures, Operation and Maintenance of Lines and Sub-stations/underground cables, Tariffs and Calculations of bills for consumption of electricity, Inventory Management, Repair and Maintenance of Electrical Machines/ Equipment, Assist in Operation and maintenance of Generating and sub-stations

## 15. PROGRAMME OUTCOMES

The program outcomes are derived from five domains of NSQF Level – 4 namely Process, Professional Knowledge, Professional Skill, Core Skill, Responsibility. After completing this level, the student will be able to:

- PO1:** Perform out task in familiar, predictable, routine situation of clear choice.
- PO2:** Acquire factual knowledge in the field of Electrical engineering for employment.
- PO3:** Demonstrate quality skills in routine and repetitive in narrow range of Electrical Engineering applications.
- PO4:** Communicate in writing and speaking with required clarity and demonstrate Professional behavior.
- PO5:** Adopt self-study learning and acquire knowledge aiming towards holistic development of learners through MOOCs.



## 16. ASSESSMENT OF PROGRAM AND COURSE OUTCOMES

Programme Outcomes to be assessed	Assessment criteria for the Course Outcomes
<p><b>PO1:</b> Perform out task in familiar, predictable, routine situation of clear choice.</p>	<ul style="list-style-type: none"> <li>• Understand the working environment of industries.</li> <li>• Take necessary safety precautions and measures.</li> <li>• Learn about present and future requirement of industries.</li> <li>• Work in team for solving industrial problems.</li> <li>• Develop required competencies and skills for relevant industries.</li> <li>• Comprehend the concepts of D.C. Machines, construction, armature reaction and characteristics.</li> <li>• Summarize the basics of Single and Three Phase transformers.</li> <li>• Comprehend how different types of meters work and their construction.</li> <li>• Measure different electrical parameters using measuring instruments and interpret the data.</li> <li>• Measure frequency, phase with Oscilloscope and DSOs.</li> <li>• Describe different Semiconductor devices and explain their characteristics</li> <li>• Acquire the knowledge of different types of transistor and transistor as an amplifier.</li> <li>• Comprehend the concept and properties of different Electrical Engineering materials.</li> </ul>

	<ul style="list-style-type: none"><li>• Describe different types of constructional materials, use and apply the knowledge testing.</li><li>• State the basic concepts and principles about the subject of interest.</li><li>• Select and learn the subject related to own interest.</li><li>• Recognize various electrical devices and their symbols and knowledge of placement of panels/distribution boards in domestic, industrial and commercial installation.</li><li>• Draw and read the installation plane, wiring and control diagram of electrical circuits.</li><li>• Read schematic and wiring diagrams of electrical machine and devices</li><li>• Communicate effectively with an increased confidence; read, write and speak in English language fluently.</li><li>• Illustrate use of communication to build a positive self-image through self-expression and develop more productive interpersonal relationships.</li><li>• Acquire knowledge about various components of PLC.</li><li>• Interpret the salient features of microcontrollers IC 8051</li><li>• Operate and control three phase synchronous generator and motor</li><li>• Identify and connect starters for starting three phase and single phase induction motors</li><li>• Differentiate between normal and Energy Efficient Motors</li></ul>
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|  | <ul style="list-style-type: none"><li>• Comprehend the concept of estimation, costing and purchasing, tender, EMD, and tender document and prepare a tender document for a particular job.</li><li>• Estimate and calculate costing of overhead &amp; underground transmission distribution line and substations.</li><li>• Identify most appropriate heating and welding techniques for suitable applications.</li><li>• Learn the basic Principle of Electric Drive and apply as per applications.</li></ul> |
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**PO2:** Acquire factual knowledge in the field of Electrical engineering for employment.

- Learn about present and future requirement of industries.
- Develop required competencies and skills for relevant industries.
- Comprehend the concepts of D.C. Machines, construction, armature reaction and characteristics.
- Analyze the speed-torque characteristics, testing of DC motor.
- Illustrate the working of different types of special purpose transformer.
- Determine the efficiency and Regulation of Transformer by various tests.
- Summarize the basics of Single and Three Phase transformers.
- Comprehend how different types of meters work and their construction.
- Apply their knowledge to measure electrical quantities using standard analog and digital measuring instruments.
- Measure different electrical parameters using measuring instruments and interpret the data.
- Measure frequency, phase with Oscilloscope and DSOs.
- Describe the working principle, selection criteria and applications of various transducers used in measurement systems.
- Describe different Semiconductor devices and explain their characteristics
- Acquire the knowledge of different types of transistor and transistor as an amplifier.
- Evaluate and realize the various digital circuits by using number system and logic gates.

	<ul style="list-style-type: none"><li>• Comprehend the concept and properties of different Electrical Engineering materials.</li><li>• Apply knowledge of practical applications of materials in different Electrical Engineering field.</li><li>• Describe different types of constructional materials, use and apply the knowledge testing.</li><li>• Select and learn the subject related to own interest.</li><li>• Explore latest developments in the field of interest.</li><li>• Recognize various electrical devices and their symbols and knowledge of placement of panels/distribution boards in domestic, industrial and commercial installation.</li><li>• Draw and read the installation plane, wiring and control diagram of electrical circuits.</li><li>• Read schematic and wiring diagrams of electrical machine and devices</li><li>• Illustrate use of communication to build a positive self-image through self-expression and develop more productive interpersonal relationships.</li><li>• Acquire knowledge about various components of PLC.</li><li>• Interface I/O devices with the PLC modules.</li><li>• Develop PLC ladder programs for various applications.</li><li>• Operate and control three phase synchronous generator and motor</li><li>• Operate and control speed of three phase squirrel cage and three phase slip ring induction motor.</li><li>• Identify and connect starters for starting three phase and single phase induction motors</li><li>• Control speed of single phase induction motors</li></ul>
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	<ul style="list-style-type: none"> <li>• Differentiate between normal and Energy Efficient Motors</li> </ul>
	<ul style="list-style-type: none"> <li>• Comprehend the concept of estimation, costing and purchasing, tender, EMD, and tender document and prepare a tender document for a particular job.</li> <li>• Design the level of illumination based on applications</li> <li>• Identify most appropriate heating and welding techniques for suitable applications.</li> <li>• Illustrate the fundamentals on electrolytic and electrometallurgical processes.</li> <li>• Learn the basic Principle of Electric Drive and apply as per applications.</li> <li>• Familiarize with MATLAB programming and Simulink.</li> </ul>
<b>PO3:</b> Demonstrate quality skills in routine and repetitive in narrow range of Electrical Engineering applications.	<ul style="list-style-type: none"> <li>• Learn about present and future requirement of industries.</li> <li>• Develop required competencies and skills for relevant industries.</li> <li>• Comprehend the concepts of D.C. Machines, construction, armature reaction and characteristics.</li> <li>• Analyze the speed-torque characteristics, testing of DC motor.</li> <li>• Illustrate the working of different types of special purpose transformer.</li> <li>• Determine the efficiency and Regulation of Transformer by various tests.</li> <li>• Summarize the basics of Single and Three Phase transformers.</li> <li>• Comprehend how different types of meters work and their construction.</li> </ul>

	<ul style="list-style-type: none"> <li>• Apply their knowledge to measure electrical quantities using standard analog and digital measuring instruments.</li> </ul>
<p><b>PO4:</b> Communicate in writing and speaking with required clarity and demonstrate Professional behavior.</p>	<ul style="list-style-type: none"> <li>• Develop required competencies and skills for relevant industries.</li> <li>• Develop required competencies for effective communication and presentation</li> <li>• Perform in a better way in the professional world.</li> <li>• Select and learn the subject related to own interest.</li> <li>• Develop the habit of self-learning through online courses. Communicate effectively with an increased confidence; read, write and speak in English language fluently.</li> <li>• Comprehend special features of format and style of formal communication through various modes.</li> <li>• Write a Report, Resume, make a Presentation, Participate in GDs and Face Interviews</li> <li>• Illustrate use of communication to build a positive self-image through self-expression and develop more productive interpersonal relationships.</li> <li>• Create user interfaces with charts, graphs, and buttons using LabView.</li> </ul>

<p><b>PO5:</b> Adopt self-study learning and acquire knowledge aiming towards holistic development of learners through MOOCs.</p>	<ul style="list-style-type: none"> <li>• Learn about present and future requirement of industries.</li> <li>• Work in team for solving industrial problems.</li> <li>• Develop required competencies and skills for relevant industries.</li> <li>• Develop required competencies for effective communication and presentation</li> <li>• State the basic concepts and principles about the subject of interest.</li> <li>• Perform in a better way in the professional world.</li> <li>• Select and learn the subject related to own interest.</li> <li>• Explore latest developments in the field of interest.</li> <li>• Develop the habit of self-learning through online courses.</li> <li>• Communicate effectively with an increased confidence; read, write and speak in English language fluently.</li> <li>• Comprehend special features of format and style of formal communication through various modes.</li> <li>• Write a Report, Resume, make a Presentation, Participate in GDs and Face Interviews</li> <li>• Illustrate use of communication to build a positive self-image through self-expression and develop more productive interpersonal relationships.</li> </ul>
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# **17. SUBJECTS & CONTENTS**

## **(SECOND YEAR)**

## THIRD SEMESTER

3.1	Industrial/In-House Training – I	70-71
3.2	Electrical Machines – I	72-75
3.3	Electrical Measurement & Instrumentation	76-79
3.4	Analog & Digital Electronics	80-83
3.5	Electrical Engineering Materials	84-86
3.6	Open Elective	87-89
3.7	Electrical Engineering Drawing	90-92

### 3.1 INDUSTRIAL / IN-HOUSE TRAINING-I

L	P
-	2

#### RATIONALE

Industrial training / In – house training will help the students to understand the working environment of relevant industries. The student will learn to work in team to solve the industrial problems. It will also give exposure about the present and future requirements of the relevant industries. This training is very import and for development of required competencies and skills for employment and start– ups.

#### COURSE OUTCOMES

After undergoing the training, the students will be able to:

- CO1: Understand the working environment of industries
- CO2: Take necessary safety precautions and measures.
- CO3: Learn about present and future requirement of industries.
- CO4: Work in team for solving industrial problems
- CO5: Develop competencies and skills required by relevant industries.
- CO6: Develop writing, speaking and presentations skills.

#### PRACTICAL EXERCISES

1. Report writing based on industrial training.
2. Preparation of Power Point Slides based on industrial training and presentation by the candidate.
3. Internal Evaluation based on quality of Report, PPT preparation, PPT presentation and answer to queries.
4. External Evaluation based on quality of Report, PPT preparation, PPT presentation and answer to queries.

## GUIDELINES

Students will be evaluated based on Industrial training / In – house training report and their presentation using Power Point about the knowledge and skills gained during the training. The Head of the Department will depute faculty coordinators by assigning a group of students to each. The coordinators will mentor and guide the students in preparing the PPTs for final presentation.

The following performance parameters are to be considered for assessment of the students out of 100 marks:

	Parameter	Weightage
i	Industrial / In-house assessment of the candidate by the trainer	40%
ii	Report Writing	20%
iii	Power Point Presentation	20%
iv	Viva-voce	20%

## 3.2 ELECTRICAL MACHINES – I

<b>L</b>	<b>P</b>
<b>3</b>	<b>4</b>

### RATIONALE

Electrical machines is a subject where a student will deal with various types of electrical machines which are employed in industries, power stations, domestic and commercial appliances etc. After studying this subject, an electrical diploma holder must be competent to repair and maintain these machines and give suggestions to improve their performance. Practical aspects of the subject will make the students capable of performing various tests on the machines as per latest BIS specifications

### COURSE OUTCOMES

After undergoing the subject, student will be able to:

- CO1: Comprehend the concepts of D.C. Machines, construction, armature reaction and characteristics.
- CO2: Analyze the speed-torque characteristics, testing of DC motor.
- CO3: Illustrate the working of different types of special purpose transformer.
- CO4: Determine the efficiency and Regulation of Transformer by various tests.
- CO5: Summarize the basics of Single and Three Phase transformers.

### DETAILED CONTENTS

#### UNIT I

##### DC Generators

- 1.1 Introduction to Electrical Machines: Definition of motor and generator, Torque development due to alignment of two fields and the concept of torque angle, Generalized theory of electrical machines.
- 1.2 DC generator: construction, parts, materials and their functions. Principle of operation of DC generator, e.m.f. equation of generator, armature reaction, commutation. Various types of DC generator. Applications of DC generators.

## UNIT II

### DC Motors

- 2.1 DC motor: Types of DC motors, Principle of operation, characteristics, Back e.m.f. and its significance, Voltage equation of DC motor. Torque and Speed; Armature torque, Shaft torque, BHP, losses, efficiency, Electric Braking. Applications of DC motors.
- 2.2 DC motor starters: Necessity, three point and four point starters. Speed control of DC shunt and series motor: Flux and Armature control. Determination of losses by Swinburne's test. Brushless DC Motor: Construction and working, rating and specifications of DC machines

## UNIT III

### Single Phase Transformers

- 3.1 Introduction, Types of transformers: Shell type and core type; Construction: Parts and functions, materials used for different parts; Principle of operation, EMF equation of transformer: Derivation, Voltage transformation ratio.
- 3.2 Transformer No-load and on-load phasor diagram. Mutual and leakage fluxes, Leakage reactance. Equivalent circuit of transformer: Equivalent resistance and reactance. Voltage regulation and Efficiency. Open circuit and short circuit tests, all day efficiency. Rating and Specifications of single phase transformer.

## UNIT IV

### Three Phase Transformers

- 4.1 Construction of three phase transformers and accessories of transformers such as Conservator, breather, Buchholtz Relay, Tap Changer (off load and on load) (Brief idea). Types of three phase transformer i.e. delta-delta, delta-star, star-delta and star-star.
- 4.2 Need of parallel operation of three phase transformer, Conditions for parallel operation. Polarity tests. Criteria for selection of distribution transformer, and power transformer, Amorphous Core type Distribution Transformer. Cooling of transformer. Specifications of three-phase distribution transformers.

## UNIT V

### Special Purpose Transformers

- 5.1 Single phase and three phase auto transformers: Construction, working and applications. Instrument Transformers: Construction, working and applications of Current transformer and Potential transformer.

- 5.2 Isolation transformer: Constructional Features and applications. Single phase welding transformer: constructional features and applications. 'K' factor of transformers: overheating due to non-linear loads and harmonics.

### **PRACTICAL EXERCISES**

1. To measure the angular displacement of rotor of the three phase synchronous machine with respect to the stator on application of DC to the field winding and simultaneously to each phase-winding in sequence

***OR***

Measurement of the angular displacement of the rotor of a slip-ring induction motor on application of DC to stator of motor winding in sequence and simultaneously to each phase of rotor winding

2. Speed control of DC shunt motor (i) Armature control method (ii) Field control method
3. Study of DC series motor with starter (to operate the motor on no load for a moment)
4. Determine efficiency of DC motor by Swinburne's Test at (i) rated capacity (ii) half full load
5. To perform open circuit and short circuit test for determining: (i) equivalent circuit (ii) the regulation and (iii) efficiency of a transformer from the data obtained from open circuit and short circuit test at full load
- 6 To find the efficiency and regulation of single phase transformer by actually loading it.
7. Checking the polarity of the windings of a three phase transformer and connecting the windings in various configurations
8. Finding the voltage and current relationships of primary and secondary of a three phase transformer under balanced load in various configurations conditions such as (a) Star-star (b) Star-delta (c) Delta-star (d) Delta - Delta configuring conditions.

### **RECOMMENDED BOOKS**

1. SK Bhattacharya, "Electrical Machines", Tata Mc Graw Hill, Education Pvt Ltd. New Delhi.
2. SK Sahdev, "Electrical Machines", Uneek Publications, Jalandhar.
3. Nagrath and Kothari, "Electrical Machines", Tata Mc Graw Hill, New Delhi.
4. JB Gupta, "Electrical Machines", SK Kataria and Sons, New Delhi.
5. Smarajit Ghosh, "Electrical Machines", Pearson Publishers, Delhi.
- 6.

## SUGGESTED WEBSITES

1. <http://swayam.gov.in>
2. <https://nptel.ac.in/>

## INSTRUCTIONAL STRATEGY

Electrical machines being a core subject of electrical diploma curriculum, where a Student will deal with various types of electrical machines which are employed in industry, power stations, domestic and commercial appliances etc. After studying this subject, an electrical diploma holder must be competent to repair and maintain these machines and give suggestions to improve their performance. Special care has to be taken on conceptual understanding of concepts and principles in the subject. For this purpose exposure to industry, work places, and utilization of various types of electrical machine for different applications may be emphasized. Explanation of practical aspects of the subject will make the students capable of performing various tests on the machines as per latest BIS specifications. This subject contains five units of equal weightage.



### 3.3 ELECTRICAL MEASUREMENT & INSTRUMENTATION

<b>L</b>	<b>P</b>
<b>3</b>	<b>4</b>

#### RATIONALE

Diploma holders in Electrical Engineering have to work on various jobs in the field as well as in testing laboratories and on control panels, where he performs the duties of installation, operation, maintenance and testing by measuring instruments. Persons working on control panels in power plants, substations and in industries will come across the use of various types of instruments and have to take measurements. Instruments used to read and observe the general electrical quantities like current, voltage, power, energy, frequency, resistance etc and their wave shapes, have been incorporated in this subject.

#### COURSE OUTCOMES

After undergoing the subject, student will be able to:

- CO1: Comprehend how different types of meters work and their construction.
- CO2: Apply their knowledge to measure electrical quantities using standard analog and digital measuring instruments.
- CO3: Measure different electrical parameters using measuring instruments and interpret the data.
- CO4: Measure frequency, phase with Oscilloscope and DSOs.
- CO5: Describe the working principle, selection criteria and applications of various transducers used in measurement systems.

#### DETAILED CONTENTS

##### UNIT I

##### Measurements of Voltage and Current

- 1.1 Significance of measurement, errors in measurement, types of error, Classification of measuring instruments: indicating, recording and integrating instruments; Essential requirements of an indicating instruments.

- 1.2 Concept of Ammeter, voltmeter, ammeter, construction, working principle, merits, demerits and comparison of moving coil, moving iron meter, rectifier type – Extension of range and calibration of voltmeter and ammeter – Errors and compensation..

## **UNIT II**

### **Measurement of Power and Electrical Energy**

- 2.1 Construction, working principle, merits and demerits of dynamometer wattmeter, Digital wattmeter, Active and reactive power measurement by , two and three wattmeter method. Effect of Power factor on wattmeter reading in two wattmeter method, Maximum Demand indicator.
- 2.2 Construction, working principle, merits and demerits of single-phase and three-phase energy meters (Induction type), Errors and their compensations, Calibration of energy meter using direct loading. Digital energy meter (diagram, construction and application).

## **UNIT III**

### **Measurement of other Instruments**

- 3.1 Construction, working principle and application of Meggar, Earth tester (analog and digital), multi-meter (analog and digital), Frequency meter (dynamometer type), single power factor meter (Electrodynamometer type). Working principle of synchroscope and phase sequence indicator, tong tester (Clamp-on meter), Study of LCR meters and their applications .Construction, working and applications of CT and PT.
- 3.2 Cathode Ray Oscilloscope: Block diagram, working principle of CRO and its various controls. Digital Storage Oscilloscope (DSO).

## **UNIT IV**

### **Transducer**

- 4.1 Introduction, Types of Transducers, Construction and principle of resistive transducer-Potentiometer –variac and strain gauges -No derivation. Only definition and formula for gauge factor, Types of strain gauges like unbonded, bonded and semiconductor. Construction and principle of Inductive transducers-L.V.D.T. and R.V.D.T, their applications.
- 4.2 Construction, principle and applications of transducers – Piezoelectric transducer, photo-conductive cells, photo voltaic cells.

## UNIT V

### Measurement of Non-Electrical Quantities

- 5.1 Temperature measurement - Construction and Working of RTD, Thermistor and Thermocouple, radiation pyrometer, technical specifications and ranges. Thermal Imager Camera (Concept).
- 5.2 Pressure measurement – Construction and working of bourdon tube, bellow diaphragm strain gauge. Measurement of pH Level.

### PRACTICAL EXERCISES

- 1. Use of analog and digital multimeter for measurement of voltage, current (A.C/D.C) and resistance.
- 2. To measure the value of earth resistance using earth tester.
- 3. To measure power, power factor in a single-phase circuit, using wattmeter and power factor meter and to verify results with calculations.
- 4. Measurement of power and power factor of a three-phase balanced load by two wattmeter method.
- 5. Measurement of voltage and frequency of a sinusoidal signal using CRO and draw wave shape of signal.
- 6. Measurement of power in a 3 phase circuit using CT, PT and 3-phase wattmeter.
- 7. Use of LCR meter for measuring inductance, capacitance and resistance.
- 8. To record all electrical quantities from the meters installed in the institution premises.
- 9. To measure Energy at different Loads using Single Phase Digital Energy meter.
- 10. Calibration of single phase and three-phase energy meter.
- 11. Measurement of pressure by using LVDT.
- 12. To measure temperature using a thermo-couple
- 13. Measurement of temperature by using thermister/Thermal Imager.
- 14. To measure the strain using electrical strain gauge
- 15. To measure the pH level using pH meter.

### RECOMMENDED BOOKS

- 1. A.K. Sawhney, “Electric and Electronic Measurement and Instrumentation”, Dhanpat Rai and Co. Author, 2014.
- 2. C.S Rangan, G.R.Sharma. and V.S.V.Mani, “Instrumentation Devices and System”, Pen Ram International Publishing India Pvt. Ltd., Fifth Edition.

3. V.K. Mehta, “Electronics and Instrumentation”, S. Chand and Company Pvt. Ltd. Reprint, 2010.
4. S.K. Singh, “Industrial Instrumentation and Control”, Tata McGraw-Hill, 1987.
5. J.G. Joshi, “Electronic Measurement and Instrumentation”, Khanna Publishing House, New Delhi .
6. SK Sahdev, “Electrical Measurements and Measuring Instruments”, Uneek International Publications, Jalandhar.
7. SK Bhattacharya, and KM Rastogi, “Experiments in Basic Electrical Engineering”, New Age International (P) Ltd., Publishers, New Delhi.
8. JB Gupta, “Electrical Measurement and Measuring Instruments”, SK Kataria and Sons, New Delhi.
9. ML Anand, “Electrical Measurement and Measuring Instruments”, SK Kataria and Sons, New Delhi.

### **SUGGESTED WEBSITES**

1. <http://swayam.gov.in>
2. <https://nptel.ac.in/>

### **INSTRUCTIONAL STRATEGY**

After making the student familiar with measuring instruments, they should be made conceptually clear about the constructional features and make them confident in making connection of various measuring instruments. Teacher should demonstrate the application of each measuring instrument in laboratory and encourage students to use them independently. This subject contains five units of equal weightage.

### 3.4 ANALOG & DIGITAL ELECTRONICS

<b>L</b>	<b>P</b>
<b>3</b>	<b>2</b>

#### RATIONALE

This subject gives the knowledge of fundamental concepts and principles of basic electronics and aims at providing the students with basic understanding of various types of materials based on their conductivity. Students will study p-n junction, rectifiers and their significance, filters, basic structure and working principle of transistors in various configurations. This course also gives the knowledge to make the students know about the fundamental principles of digital electronics and gain familiarity with the available IC chips.

#### COURSE OUTCOMES

After completing this course, student will be able to:

- CO1: Describe different Semiconductor devices and explain their characteristics
- CO2: Acquire the knowledge of different types of transistor and transistor as an amplifier.
- CO3: Evaluate and realize the various digital circuits by using number system and logic gates.
- CO4: Analyze sequential and combinational digital circuits and converters.

#### DETAILED CONTENTS

##### UNIT I

##### Semiconductor Devices

- 1.1 Concept of insulators, conductors and semiconductors. Intrinsic and extrinsic semiconductor, P and N type semiconductor and their conductivity. Effect of temperature on conductivity of intrinsic semiconductor etc.

- 1.2 PN junction diode, mechanism of current flow in PN junction, forward and reverse biased PN junction, potential barrier, drift and diffusion currents, depletion layer. V-I characteristics of diodes. Diode as half-wave, full wave and bridge rectifiers. Peak Inverse Voltage, rectification efficiencies and ripple factor calculations, Concept of filters. Types of diode, characteristics and applications of Zener diodes.

## **UNIT II**

### **Bipolar-Transistors and Field Effect Transistors**

- 2.1 Concept of a bipolar transistor, PNP and NPN transistors. CB, CE, CC configurations of a transistor. Transistor as an amplifier in CE Configuration, Current amplification factors, Comparison of CB, CE and CC Configurations.
- 2.2 Construction, operation and characteristics of FETs. FET as an amplifier. Construction, operation and characteristics of a MOSFET. Comparison of JFET, MOSFET and BJT.

## **UNIT III**

### **Digital Electronics**

- 3.1 Distinction between analog and digital signal. Decimal, Binary, octal and hexadecimal number system. Conversion from decimal and hexadecimal to binary and vice-versa. Binary addition and subtraction.
- 3.2 Definition, symbols and truth tables of Logic gates (AND, OR, XOR, NOT, NAND, NOR and XNOR).

## **UNIT IV**

### **Sequential and Combinational Circuit**

- 4.1 Sequential Circuits such as Half adder, Full adder, Mux, De-Mux, Encoder and Decoder. Combinational Circuits like Latch, Flip Flops, shift registers and counters.

## 4.2 A/D and D/A Converters and its Applications.

### **PRACTICAL EXERCISES**

1. To Plot V-I characteristics of a PN junction diode.
2. To Plot V-I characteristics of a Zener diode.
3. Observe the output of waveform:
4. Half-wave rectifier circuit using one diode
5. Full-wave rectifier circuit using two diodes
6. Observe the output of waveform of Bridge-rectifier circuit using four diodes.
7. Plotting of input and output characteristics and calculation of parameters of transistors in CE configuration.
8. Plotting of input and output characteristics and calculation of parameters of transistors in CB configuration.
9. Plotting of V-I characteristics of a FET.
10. Basic logic operations of AND, OR, NOT gates.
11. Verification of truth tables for NAND, NOR and Exclusive OR (EX-OR) and Exclusive NOR (EX-NOR) gates.
12. Realization of logic functions with the help of NAND or NOR gates.
13. To design a half adder using XOR and NAND gates and verification of its operations.
14. Construction of a full adder circuit using XOR and NAND gates and verify its operation
15. Verification of truth table for IC flip-flops (At least one IC each of D latch, D flip-flop, JK flip-flops).
16. Verification of truth table for encoder and decoder ICs.

17. Verification of truth table for Mux and De-Mux.

### RECOMMENDED BOOKS

1. Kulshreshta and S.C. Gupta, Basic Electronics and linear circuit by Tata Mc Graw Hill Education Pvt. Ltd., New Delhi.
2. V.K. Mehta, Principles of Electrical and Electronics Engineering by S Chand Co., New Delhi.
3. Millman and Halkias, Electronics Device and Circuit by Mc Graw Hill.
4. Albert Paul Malvino, "Principles of Electronics" by Tata Mc Graw Hill Education Pvt Ltd
5. S K Sahdev, "Electronic Principles "by Dhanpat Rai & Co., New Delhi.
6. J B Gupta, "Basic Electronics "by S K Kataria and Sons, New Delhi
7. Schultz Grob's, Basic Electronics, Altext Lab Manual by Tata Mc Graw Hill Education Pvt. Ltd., New Delhi.
8. Anand Kumar "Fundamentals of Digital Circuits" PHI
9. Anil K. Maini "Digital Electronics: Principles And Integrated Circuit", Wiley Publications
10. R P Jain- "Modern Digital Electronics"-Tata McGraw Hill.

### SUGGESTED WEBSITES

1. <http://swayam.gov.in>
2. <https://nptel.ac.in/>

### INSTRUCTIONAL STRATEGY

After making the student familiar with semiconductors, they should be made conceptually clear about the constructional features and make them confident in making connection of various electronic devices. This subject contains four units of equal weightage.



### 3.5 ELECTRICAL ENGINEERING MATERIALS

**L    P**  
**3    -**

#### **RATIONALE**

A diploma holder in Electrical Engineering will be involved in maintenance, repair and production of electrical equipment and systems. A sound knowledge of the properties, characteristics, applications and limitation of engineering materials is a must for every Engineer and Technologist. In this subject, effort is made to develop skill in the Electrical diploma students to inspect and select the right material as per engineering applications.

#### **COURSE OUTCOME**

After undergoing the subject, student will be able to:

CO1: Comprehend the concept and properties of different Electrical Engineering materials.

CO2: Apply knowledge of practical applications of materials in different Electrical Engineering field.

CO3: Describe different types of constructional materials, use and apply the knowledge testing.

#### **DETAILED CONTENTS**

##### **UNIT I**

##### **Introduction to Materials**

Classification of materials such as conducting, semi conducting, insulating materials, magnetic material. Atomic theory, Energy band theory. Classifications of materials on the basis of atomic structure and energy bands. Characteristics of materials.

##### **UNIT II**

##### **Conducting and Semi-Conducting Materials**

2.1 Types of conducting material such as low resistivity and high resistivity materials.

2.2 Properties and applications of different low resistivity materials such as silver, Gold, copper (hard drawn, annealed copper), aluminum, steel, ACSR and its alloys like copper

alloy (brass, bronze) etc. Properties and applications of different high resistivity material such as carbon, tungsten, platinum, mercury, lead, and its alloys like Constantan or eureka, Brass phosphor bronze, nichrome, manganin, tin-lead alloy etc.

- 2.3 Semi-conductors Materials and their Applications, Commonly used semiconducting material Germanium and silicon and their properties. Types of Semiconductor etc.

### **UNIT III**

#### **Insulating Materials**

- 3.1 Characteristics of good Insulating material, Electrical, thermal, chemical, visual, mechanical, physical properties of Insulating materials. Types of Insulating materials. classification of insulating material on the basis of temperature.
- 3.2 Gaseous Insulating Materials: Properties and applications of air, nitrogen and sulphur hexafluoride (SF-6) gases. Liquid Insulating Materials: Properties and applications of Mineral and Insulating oil for transformers (mineral oil), switchgears etc, synthetic insulating liquid (Pyranol).
- 3.3 Solid Insulating Materials: Properties, types and applications of Plastics such as poly-vinyl chloride (PVC), Polyethylene, polystyrene, epoxy resin, Bakelite, Melamines, silicon resins etc. Natural Insulating materials, properties and their applications: Mica, asbestos, ceramic materials (porcelain and steatite), Glass, Cotton, Silk, Jute, Paper (dry and impregnated) Rubber, Bitumen, Teflon, Silicon Grease , Insulating varnishes for coating and impregnation, Enamels for winding wires, wood etc.

### **UNIT IV**

#### **Magnetic Materials**

Characteristics and types of magnetic material, Properties of soft magnet material like Iron silicon alloy, Nickel iron alloy, Mu metal, soft ferrites, grain orientation, Cold rolled grain oriented silicon steels (C.R.G.O) etc. and their applications. Properties of hard magnet material like Tungsten steel alloy, chromium steel, cobalt steel, Hard ferrites etc. and their applications.

### **UNIT V**

#### **Special Purpose Materials**

Thermocouples, Bimetals, soldering, fuse, materials and their applications. Material used in fabrications of electrical machines such as motors, generators, transformers etc

**RECOMMENDED BOOKS**

1. SK Bhattacharya, “Electrical and Electronic Engineering Materials”, Khanna Publishers, New Delhi.
2. Grover and Jamwal, “Electronic Components and Materials”, Dhanpat Rai and Co., New Delhi.
3. SK Sahdev, “Electrical Engineering Materials”, Unique International Publications, Jalandhar.
4. SM Dhir, “Electronic Components and Materials”, Tata Mc Graw Hill, New Delhi.
5. PL Kapoor, “Electrical Engineering Materials”, Khanna Publishers, New Delhi.
6. BR Sharma and Others, “Electrical and Electronics Engineering Materials”, Satya Parkashan, New Delhi.
7. e-books/e-tools/relevant software to be used as recommended by AICTE/HSBTE/NITTTR.

**SUGGESTED WEBSITES**

1. <http://swayam.gov.in>
2. <https://nptel.ac.in/>

**INSTRUCTIONAL STRATEGY**

The teacher should bring different materials, electronic components and devices in the class while taking lectures and explain and make students familiar with them. Also he may give emphasis on practical applications of these devices and components in the field. In addition, the students should be given exercises on identification of materials used in various electronic gadgets etc .and be encouraged to do practical work independently and confidently. This subject contains five units of equal weightage.

### 3.6 OPEN ELECTIVE

L	P
2	-

#### RATIONALE

Open electives are very important and play major role in implementation of National Education Policy. These subjects provide greater autonomy to the students in the curriculum, giving them the opportunity to customize it to reflect their passions and interests. The system of open electives also encourages cross learning, as students pick and choose subjects from the different streams.

#### COURSE OUTCOMES

At the end of the open elective, the students will be able to:

- CO1: State the basic concepts and principles about the subject of interest.
- CO2: Perform in a better way in the professional world.
- CO3: Select and learn the subject related to own interest.
- CO4: Explore latest developments in the field of interest.
- CO5: Develop the habit of self-learning through online courses.

#### LIST OF OPEN ELECTIVES

**(The list is indicative and not exhaustive)**

1. Computer Application in Business
2. Introduction to NGO Management
3. Basics of Event Management
4. Event Planning
5. Administrative Law
6. Introduction to Advertising
7. Moodle Learning Management System
8. Linux Operating System
9. E-Commerce Technologies
10. NCC
11. Marketing and Sales

12. Graphics and Animations
13. Digital Marketing
14. Human Resource Management
15. Supply Chain Management
16. TQM

## **GUIDELINES**

Open Elective shall be offered preferably in online mode. Online mode open elective shall preferably be through Massive Open Online Courses (MOOCs) from Swayam, NPTEL, Upgrad, Udemy, Khan Academy or any other online portal to promote self-learning. A flexible basket of large number of open electives is suggested which can be modified depending upon the availability of courses at suggested portals and requirements. For online open electives, department coordinators shall be assigned to monitor and guide the group of students for selection of minimum 20 hours duration online course of their choice. For offline open electives, a suitable relevant subject shall be offered by the respective department to the students with minimum 40% of the total class strength as per present and future requirements.

Assessment of MOOCs open elective shall be based on continuous evaluation by the respective coordinator. The coordinator shall consider the submitted assignments by the students from time to time during the conduct of MOOCs. The MOOCs assessment shall be conducted by the coordinator along with one external expert by considering submitted assignments out of 100 marks.

In case, no suitable open elective is available online, only then the course may be conducted in offline mode. The assessment of offline open elective shall be internal and external. The offline open elective internal assessment of 40 marks shall be based on internal sessional tests; assignments etc. and external assessment of 60 marks shall be based on external examination at institute level.

## **NOTE**

The students enrolled under NCC will compulsorily undertake NCC as an open elective subject.

## **SUGGESTED WEBSITES**

1. <https://swayam.gov.in/>
2. <https://www.udemy.com/>
3. <https://www.upgrad.com/>
4. <https://www.khanacademy.org/>

### 3.7 ELECTRICAL ENGINEERING DRAWING

**L    P**  
**-    6**

#### **RATIONALE**

A student of electrical engineering is supposed to have ability to: -

- i. Read, understand and interpret engineering drawings.
  - ii. Communicate and co-relate through sketches and drawings.
  - iii. Prepare working drawings of panels, transmission and distribution
- The contents of this subject has been designed to develop requisite knowledge and skills of electrical drawings in the students of diploma in electrical engineering.

#### **COURSE OUTCOMES**

After undergoing the subject, students will be able to:

- CO1: Recognize various electrical devices and their symbols and knowledge of placement of panels/distribution boards in domestic, industrial and commercial installation.
- CO2: Draw and read the installation plane, wiring and control diagram of electrical circuits.
- CO3: Read schematic and wiring diagrams of electrical machine and devices.
- CO4: Communicate about circuits and devices through sketches and drawings.

#### **DETAILED CONTENTS CUM PRACTICAL EXERCISES**

##### **UNIT I**

##### **Simple Electrical Circuits**

- 1.1 Electrical Symbols used in Electrical installation; Schematic , single line and wiring diagrams of light and fan point controlled by individual switches, fluorescent tube controlled by one-way switch, one lamp controlled by two switches (staircase circuit) three lamps controlled by four switches (Corridor light circuit).
- 1.2 Design and Drawing of panels/Distribution board using MCB, ELCB main switches and change over switches for domestic installation, industrial and commercial installation.

## **UNIT II**

### **Contractor Control Circuits**

Design of circuit drawing of schematic diagram and power wiring diagram of following circuits, specification of contactors:-

- 2.1 DOL starting of 3-phase induction motor
- 2.2 3-phase induction motor getting supply from selected feeder
- 2.3 Forwarding/reversing of a 3-phase induction motor
- 2.4 Two speed control of 3-phase induction motor
- 2.5 Sequential operating of two motors using time delay relay
- 2.6 Manually generated star delta starter for 3-phase induction motor
- 2.7 Automatic star delta starter for 3-phase Induction Motor

## **UNIT III**

### **Professional Control Circuits**

- 3.1 Draw the wiring diagram of battery and inverter connected to residential load.
- 3.2 Draw the wiring diagram of standalone solar light system with battery for a residential house.
- 3.3 Draw the wiring diagram of solar water heating system.
- 3.4 Key diagram of 11kV, 33kV, 66kV, 132 kV sub-stations
- 3.5 Draw pipe and plate Earthing.

## **UNIT IV**

### **Orthographic Projections of Simple Electrical Parts**

- 4.1 Bus bar post
- 4.2 Kit Kat Fuse
- 4.3 Pin type insulator (Pin Type 11kV/66kV)
- 4.4 Rotor of a squirrel cage induction motor
- 4.5 Stator of 3 phase Induction motor (Sectional View)

## **RECOMMENDED BOOKS**

1. Surjeet Singh, “Electrical Engineering Design and Drawings, Dhanpat Rai and Co, New Delhi.
  2. SK Bhattacharya, “Electrical Engineering Design and Drawings”, SK Kataria and Sons, New Delhi.
  3. Ubhi & Marwaha, “Electrical Engineering Design and Drawings”, IPH, New Delhi.
-



4. SK Sahdev, “Electrical Design and Drawing”, Uneek Publications, Jalandhar.
5. Surjit Singh, “Electrical Engineering Drawing”, SK Kataria and Sons, New Delhi.
6. Surjit Singh, “Electrical Design and Drawing”, North Publication, Jalandhar.

### **SUGGESTED WEBSITES**

1. <http://swayam.gov.in>
2. <https://nptel.ac.in/>

### **INSTRUCTIONAL STRATEGY**

Teacher should identify/prepare more exercises on the pattern shown above. The teacher should make the students confident in making drawing and layouts of electrical wiring installations and doing estimation and costing. This capability will lead the students to become a successful entrepreneur. Take the students to field/laboratory and show the material and equipment, take the Assignments and class tests in reference to Design and Drawing. This subject contains five units of equal weightage.

## FOURTH SEMESTER

4.1	English & Communication Skills – II	93-96
4.2	Electrical Machines - II	97-100
4.3	PLC & Microcontrollers	101-104
4.4	Estimating and Costing in Electrical Engineering	105-108
4.5	Utilization of Electrical Energy	109-111
4.6	Programming Skills	112-113

## 4.1 ENGLISH AND COMMUNICATION SKILLS - II

<b>L</b>	<b>P</b>
<b>2</b>	<b>2</b>

### RATIONALE

Communication II moves a step further from Communication Skills I and is aimed at enhancing the linguistic competency of the students. Language as the most commonly used medium of self-expression remains indispensable in all spheres of human life – personal, social and professional. This course is intended to make fresh ground in teaching of Communicative English as per the requirements of National Skill Quality Framework.

### COURSE OUTCOMES

After undergoing this course, the learners will be able to:

- CO1: Communicate effectively with an increased confidence; read, write and speak in English language fluently.
- CO2: Comprehend special features of format and style of formal communication through various modes.
- CO3: Write a Report, Resume, make a Presentation, Participate in GDs and Face Interviews
- CO4: Illustrate use of communication to build a positive self-image through self-expression and develop more productive interpersonal relationships.

### DETAILED CONTENTS

#### UNIT I

##### Reading

- 1.1 All the World's A Stage – W. Shakespeare
- 1.2 Life Sketch of Dr. Abdul Kalam
- 1.3 The Portrait of a Lady - Khushwant Singh
- 1.4 The Doctor's Word by R K Narayan
- 1.5 Speech by Dr Kiran Bedi at IIM Indore 2007 Leadership Concepts
- 1.6 The Bet - by Anton Chekov

**UNIT II****Effective Communication Skills**

- 2.1 Modern means of Communication (Video Conferencing, e- mail, Teleconferencing)
- 2.2 Effective Communication Skills: 7 C's of Communication
- 2.3 Non-verbal Communication – Significance, Types and Techniques for Effective Communication
- 2.4 Barriers and Effectiveness in Listening Skills
- 2.5 Barriers and Effectiveness in Speaking Skills

**UNIT III****Professional Writing**

- 3.1 Correspondence: Enquiry letters, placing orders, complaint letters
- 3.2 Report Writing
- 3.3 Memos
- 3.4 Circulars
- 3.5 Press Release
- 3.6 Inspection Notes and tips for Note-taking
- 3.7 Corrigendum writing
- 3.8 Cover Letter
- 3.9 Drawing inferences

**UNIT IV****Grammar and Vocabulary**

- 4.1 Prepositions
- 4.2 Conjunctions
- 4.3 Punctuation
- 4.4 Idioms and Phrases
- 4.5 Pairs of words (Words commonly misused and confused)
- 4.6 Translation of Administrative and Technical Terms in Hindi or Mother tongue

**UNIT V****Employability Skills**

- 5.1 Presentation Skills: How to prepare and deliver a good presentation
- 5.2 Telephone Etiquettes
- 5.3 Importance of developing employable and soft skills
- 5.4 Resume Writing: Definition, Kinds of Resume, Difference between Bio-data and Curriculum Vitae and Preparing a Resume for Job/ Internship

- 5.5 Group discussions: Concept and fundamentals of GD, and learning Group Dynamics.
- 5.6 Case Studies and Role Plays

## PRACTICAL EXERCISES

1. Reading Practice of the above lessons in the Lab Activity classes.
2. Comprehension exercises of unseen passages along with the given lessons.
3. Vocabulary enrichment and grammar exercises based on the above selective readings.
4. Situational Conversation: Requesting and responding to requests; Expressing sympathy and condolence.
5. Warning; Asking and giving information.
6. Getting and giving permission.
7. Asking for and giving opinions.
8. A small formal and informal speech.
9. Seminar.
10. Debate.
11. Unseen Comprehension Passages and vocabulary enhancement.
12. Interview Skills: Preparing for the Interview and guidelines for success in the Interview and significance of acceptable body-language during the Interview.
13. Written and Oral Drills will be undertaken in the class to facilitate a holistic linguistic competency among learners.
- 5.1 Participation in a GD, Functional and Non-functional roles in GD, Case Studies and Role Plays
14. Presentations, using audio-visual aids (including power-point).
15. Telephonic interviews, face to face interviews.
16. Presentations as Mode of Communication: Persuasive Presentations using multi-media aids.

## RECOMMENDED BOOKS

1. J Sethi, Kamlesh Sadanand & DV Jindal, “Course in English Pronunciation”, PHI Learning Pvt. Ltd., New Delhi.
2. Wren and Martin, “High School English Grammar and Composition”.
3. NK Aggarwal and FT Wood, “English Grammar, Composition and Usage”, Macmillan Publishers India Ltd., New Delhi.
4. RC Sharma, and Krishna Mohan, “Business Correspondence & Report Writing”, (4<sup>th</sup> Edition), by Tata MC Graw Hills, New Delhi.

5. Varinder Kumar, Bodh Raj & NP Manocha, “Business Communication Skills”, Kalyani Publisher, New Delhi.
6. Kavita Tyagi & Padma Misra, “Professional Communication”, PHI Learning Pvt. Ltd., New Delhi.
7. Nira Konar, “Communication Skills for Professionals”, PHI Learning Pvt. Ltd., New Delhi.
8. Krishna Mohan & Meera Banerji, “Developing Communication Skills”, (2<sup>nd</sup> Edition), Macmillan Publishers India Ltd., New Delhi.
9. M. Ashraf Rizwi, “Effective Technical Communication”, Tata MC Graw Hills, New Delhi.
10. Andrea J Rutherford, “Basic Communication Skills for Technology”, Pearson Education, New Delhi.

## 4.2 ELECTRICAL MACHINES - II

<b>L</b>	<b>P</b>
<b>3</b>	<b>4</b>

### RATIONALE

Electrical machines is a subject where a student will deal with various types of electrical machines which are employed in industries, power stations, domestic and commercial appliances etc. After studying this subject, an electrical diploma holder must be competent to repair and maintain these machines and give suggestions to improve their performance. Explanation of practical aspects of the subject will make the students capable of performing various tests on the machines as per latest BIS specifications

### COURSE OUTCOMES

After undergoing the subject, students will be able to:

- CO1: Operate and control three phase synchronous generator and motor
- CO2: Operate and control speed of three phase squirrel cage and three phase slip ring induction motor.
- CO3: Identify and connect starters for starting three phase and single phase induction motors
- CO4: Control speed of single phase induction motors
- CO5: Differentiate between normal and Energy Efficient Motors

### DETAILED CONTENTS

#### UNIT I

##### Synchronous Machines

- 1.1 Main constructional features of synchronous machine including commutator
- 1.2 Generation of three phase emf
- 1.3 Production of rotating magnetic field in a three phase winding
- 1.4 E.M.F. Equation, Concept of distribution factor and coil span factor
- 1.5 Operation of single synchronous machine independently supplying a load, voltage regulation by synchronous impedance method
- 1.6 Need and necessary conditions of parallel operation of alternators, synchronizing an alternator (Synchroscope method) with the bus bars

- 1.7 Operation of synchronous machine as motor, Starting methods of Synchronous Motor
- 1.8 Concept and Cause of hunting and its prevention
- 1.9 Specification of Synchronous Machine
- 1.10 Cooling of synchronous machines
- 1.11 Application of synchronous machines (as a synchronous condenser)

## UNIT II

### Three Phase Induction Motors

- 2.1 Salient constructional features of 3 phase squirrel cage and slip ring induction motors
- 2.2 Principle of operation, slip and its significance
- 2.3 Locking of rotor and stator fields
- 2.4 Rotor resistance, inductance, e.m.f. and current
- 2.5 Relationship between copper loss and the motor slip
- 2.6 Power flow diagram of an induction motor
- 2.7 Factors determining the torque
- 2.8 Torque-slip curve, stable and unstable zones
- 2.9 Effect of rotor resistance upon the torque slip relationship
- 2.10 Starting of 3-phase induction motors by DOL, star-delta and auto transformer starter
- 2.11 Causes of low power factor of induction motors
- 2.12 Speed control of induction motor
- 2.13 Cogging and Crawling in Induction Motors.

## UNIT III

### Single Phase Induction Motors:

- 3.1 Single phase induction motors; Construction characteristics and applications
- 3.2 Nature of field produced in single phase induction motor
- 3.3 Split phase induction motor: Capacitors start and run motor, Shaded pole motor and Reluctance start motor
- 3.4 Alternating current series motor and universal motors

## UNIT IV

### Special Purpose Machines

- 4.1 Working principle of Linear induction motor, Stepper motor and Servomotor
- 4.2 Introduction to Energy efficient Motors.



## LIST OF PRACTICALS

1. To Plot relationship between no load terminal voltage and excitation current in a synchronous generator at constant speed.
2. Determination of the relationship between the terminal voltage and load current of an alternator, keeping excitation and speed constant.
3. Determination of the efficiency of alternator from the open circuit and short circuit test.
4. Parallel operation of three phase alternators.
5. Study of ISI/BIS code for 3-phase induction motors.
6. Perform at least two tests on a 3-phase induction motor as per BIS code.
7. To reverse the direction of rotation of three phase induction motor.
8. To control speed of three phase induction motor.
9. Determination of efficiency of three phase induction motor by
  - (a) No load test and blocked rotor test.
  - (b) Direct loading (refer BIS code).
10. Determination of effect of rotor resistance on torque speed curve of an induction motor.
11. To Plot Torque-Slip Characteristics of three phase induction Motor.
12. Study of performance of a ceiling fan with and without capacitor.
13. Study the effect of change in capacitor on the performance of single phase induction motor.
14. To reverse the direction of rotation of single phase induction motor.

## RECOMMENDED BOOKS

1. Bhattacharya, SK, “Electrical Machines”, Tata Mc Graw Hill, Education Pvt Ltd. New Delhi.
2. Sahdev, SK, “Electrical Machines”, Uneek Publications, Jalandhar.
3. Gupta, JB, “Electrical Machines”, SK Kataria and Sons, New Delhi.
4. Marwaha, G L, “Electrical Machines”, Eagles Publication, Jalandhar.
5. Arora, D R, “Electrical Machines I”, Ishan Publications, Ambala City.
6. Bimbhra, P.S., “Electrical Machines”, Khanna Publishers.
7. Nagrath, I.J., & D.P. Kothari, “Electric Machines”, Tata Mc Graw –Hill Publishers.

## INSTRUCTIONAL STRATEGY

Teacher should lay-emphasis on development of understanding amongst students about basic principles of operation and control of electrical machines. This may be achieved by conducting quiz tests and by giving home assignments. The teachers should also conduct laboratories classes themselves encouraging each should to perform with his/her own hands and draw conclusions. This subject contains four units of equal weight age.

## 4.3 PLC & MICROCONTROLLERS

<b>L</b>	<b>P</b>
<b>3</b>	<b>4</b>

### RATIONALE

A diploma holder when employed in automated industrial process controls or in automated power station will be required to know the basics of Programmable Logic Controllers, their working and their programming. Looking at the industrial applications of PLCs in the modern industry, this subject finds its usefulness in the present curriculum. The microprocessor has been with us for some Twenty Five years but it has limited applications, more complicated hardware, limited use with computer and more cost resulted in failure in market on other hand micro controller which is a true computer on a chip more simple in hardware, millions of application more general purpose device and capable of having several different functions depending on the wishes of the programme. So now a day, use of micro controller is increasing in industries and therefore, it is necessary for the students to study this course.

### COURSE OUTCOMES

After undergoing the subject, students will be able to:

- CO1: Acquire knowledge about various components of PLC.
- CO2: Interface I/O devices with the PLC modules.
- CO3: Develop PLC ladder programs for various applications.
- CO4: Interpret the salient features of microcontroller IC 8051
- CO5: Programme micro controllers for different operations and applications in industries.

### DETAILED CONTENTS

#### UNIT I

##### Fundamentals of PLC

Introduction, Definition and advantage; Building blocks of PLC: CPU, Memory organization, Input- output modules (discrete and analog), Specialty I/O Modules, Power supply; I/O module selection criteria; Interfacing different I/O devices with appropriate I/O modules

**UNIT II****PLC Instructions and Programming**

PLC programming Instructions: Relay type instructions, Timer instructions: On delay, off delay, retentive, counter instructions: Up, Down, High speed, Logical instructions, Comparison Instructions, Data handling Instructions, Arithmetic instructions. Simple Programming examples using ladder logic: Language based on relay, timer counter, logical, comparison, arithmetic and data handling instructions.

**UNIT III****Applications of PLC**

PLC Based Applications: Motor sequence control, Motor in forward and reverse direction, Star-Delta, DOL Starters Traffic light control, Elevator control, Conveyor system, Stepper motor control, packaging etc.

**UNIT IV****Architecture of Microcontroller 8051**

Difference between micro processor and micro controller, Block diagram of 8051, function of each block, Pin diagram, function of each pin, Concept of Internal memory and External memory (RAM and ROM), Internal RAM structure, Reset and clock circuit, Various registers and SFRs of 8051.

**UNIT V****Microcontroller Instruction and Programming**

Instruction set and addressing modes: Timer operation, Serial Port operation, interrupts: Data Transfer operations, Input/output operations. Design and Interface: keypad interface, 7- segment interface, LCD, stepper motor; applications.

**PRACTICAL EXERCISES**

1. Introduction to PLC building blocks and Ladder Programming.
2. Installation and programming using OpenPLC.
3. Logic operations in PLC using ladder language e.g. AND, OR, NOT etc.
4. Timers and Counters instructions in PLC using ladder language.
5. Sequence control system e.g. in lifting a device for packaging and counting.
6. Use of PLC in any two applications (teacher may decide):
  - a) Traffic Lights System
  - b) Doorbell Operation

- c) Home Automation
- d) Sorting of Objects
- 7. Demonstration and comparison of various 8051/8052 microcontrollers.
- 8. Introduction to 8051 programming using C.
- 9. Testing of GPIO on Micro controller board using C.
- 10. Interfacing of 7 segment LED with 8051 using C.
- 11. Interfacing of 4x3/4x4 Keypad with 8051 using C.
- 12. Any three application circuits using 8051/8052 (teacher may decide):
  - a) Car Parking with Counter
  - b) Temperature controlled Fan
  - c) RTC based digital clock
  - d) Agriculture Automation using Humidity, Soil Moisture and Temperature sensors

**NOTE: List in Experiment No. 6 and 12 are indicative in nature and teacher may choose any other circuit as well.**

### RECOMMENDED BOOKS

1. G., Dunning, “Introduction to Programmable Logic Controllers”, Thomson /Delmar Learning, New Delhi.
2. F.D. Petruzella, “Programmable Logic Controllers”, McGraw Hill India, New Delhi.
3. John Hackworth, and Federic Hackworth, “Programmable Logic Controllers”, PHI Learning, New Delhi.
4. Job Dan Otter, “Programmable Logic Controller”, P.H. International, Inc, USA.
5. Gary Dunning, “Introduction to PLCs”, McGraw Hill.
6. Gurpreet Kaur and SK Sahdev, “Programmable Logic Controller and Microcontrollers”, Uneek Publications, Jalandhar.
7. Ayala Kenneth, “8051 Microcontroller Architecture Programming and Application”, PHI Learning, New Delhi.
8. Mohmad Ali Mazidi, Janice Gelispe Mazidi, and D. MckinlayRoline, “The 8051 Microcontroller and Embedded System”, Pearson Education, Delhi.
9. Ajay Deshmukh, “Microcontroller Theory and Application”, McGraw Hill., New Delhi.
10. Raj Kamal, “Microcontroller Architecture Programming, Interfacing and System Design”, Pearson Education India, Delhi.
11. Krishna Kant, “Microprocessors and Microcontrollers: Architecture Programming and System Design”, PHI Learning, New Delhi.

## **SUGGESTED WEBSITES**

1. <http://swayam.gov.in>
2. <https://nptel.ac.in/>

## **INSTRUCTIONAL STRATEGY**

Introduce the subject and make the students familiar with applications of PLCs and Microcontrollers. The inputs shall start with theoretical inputs to architecture, instruction set, assembly language programming, Small projects may be identified, be designed and implemented. PLC ladder diagram and programming should be supplemented with visits to industry. More emphasis may be given to practical work, assignments and quiz/class tests, mid-term and end-term written tests. This subject contains five units of equal weight age.

## 4.4 ESTIMATING AND COSTING IN ELECTRICAL ENGINEERING

<b>L</b>	<b>P</b>
<b>3</b>	<b>2</b>

### RATIONALE

A diploma holder in electrical engineering should be familiar to Indian Standards and relevant Electricity Rules. Preparation of good estimates is a professional's job, which requires knowledge of materials and methods to deal with economics. The contents of this subject have been designed keeping in view developing requisite knowledge and skills of estimation and costing in students of diploma in electrical engineering.

### COURSE OUTCOMES

After undergoing the subject, student will be able to:

- CO1: Comprehend the concept of estimation, costing and purchasing, tender, EMD, and tender document and prepare a tender document for a particular job.
- CO2: Prepare details estimation and costing of domestic, industrial and street light electrical installation as per IE.
- CO3: Detail and prepare detail estimation and costing for single and three phase service connection, also installation of service connection.
- CO4: Estimate and calculate costing of overhead & underground transmission distribution line and substations.

### DETAILED CONTENTS

#### UNIT I

##### Essentials of Estimation and Costing

- 1.1 **Introduction** :Purpose of estimating and costing, proforma for making estimates, preparation of materials schedule, costing, price list, net price list, market survey, overhead charges, labour charges, electrical point method and fixed percentage method, contingency, profit.
- 1.2 **Tenders and Quotations**-Type of tender, tender notice, preparation of tender document, and method of opening of tender, Quotation-quotation format, comparison between tender and quotation, Comparative statement, format comparative statement. Earnest money deposit (EMD), purchase system, orders for supply, payment of bills.

## UNIT II

### Domestic Installation

- 2.1 **Wiring and accessories:** Introduction, types of wiring: Cleat, batten, casing capping and conduit wiring, comparison of different wiring systems, selection and design of wiring schemes. Selection of wires and cables, wiring accessories and use of protective devices i.e. MCB, ELCB etc. Use of wire-gauge and tables (to be prepared/arranged).
- 2.2 **Domestic installations:** standard practice as per IS and IE rules. Planning of circuits, sub-circuits and position of different accessories, electrical layout, preparing estimates including cost as per schedule rate pattern and actual market rate (single story and multi- story buildings having similar electrical load).

## UNIT III

### Industrial Installation

- 3.1 **Industrial installations:** relevant IE rules and IS standard practices, planning, designing and estimation of installation for single phase motors of different ratings, electrical circuit diagram, starters, preparation of list of materials, estimating and costing exercises on workshop with single-phase, 3-phase motor load and the light load (3-phase supply system).
- 3.2 Design electrical installation scheme of factory/ small industrial unit, Preparation of material schedule and detailed estimation.

## UNIT IV

### Street Lighting Installation

- 4.1 Classification of outdoor installations streetlight/ public lighting installation, Street light pole structures. Selection of equipments, sources used in street light installations. Cables, recommended types and sizes of cable. Control of street light installation.
- 4.2 Design, estimation and costing of streetlight, Preparation of tenders.

## UNIT V

### Distribution Line and LT Substation

- 4.1 Transmission and distribution lines (overhead and underground) planning and designing of lines with different fixtures, earthing etc. based on unit cost calculations .Service line connections estimate for domestic and industrial loads (overhead and underground connections) from pole to energy meter.
- 4.2 Substation: Types of substations, substation schemes and components, estimate of 11/0.4 kV pole mounted substation up to 200 kVA rating, earthing of substations.



## PRACTICAL EXERCISES

1. Prepare a tender notice for purchasing a transformer of 200 KVA for commercial installation.
2. Prepare a quotation for purchasing different electrical material required.
3. Prepare a comparative statement for above material. Prepare purchase order for the same.
4. Prepare an estimate for a Two room residential building as per given plan.
5. Design electrical installation scheme for any one factory / small industrial unit. Draw detailed wiring diagram. Prepare material schedule and detailed estimate. Prepare report and draw sheet.
6. Estimate with a proposal of the electrical Installation of streetlight scheme for small premises after designing.
7. Prepare an estimate for service connection for residential building having connected load ---- kW.
8. Estimate with a proposal of the L.T. line installation. Prepare report and draw sheet.
9. Estimate with a proposal of the 500 KVA, 11/0.433 KV outdoor substation and prepare a report.
10. Visit a nearby substation and list the components with diagram

## RECOMMENDED BOOKS

1. K.B Raina, and Dr. S. K. Bhattacharya, “Electrical Design Estimating and Costing”, New Age International Publisher First, Reprint 2010, ISBN: 978-81-224-0363-3.
2. Allagappan,, N. S. Ekambarram, “Electrical Estimating and Costing”, Tata Mc-Graw Hill Publishing Co. Ltd, ISBN 13: 9780074624784.
3. JB Gupta, “Electrical Installation, Estimating and Costing”, SK Kataria and Sons, New Delhi.
4. Surjit Singh, and Ravi Deep Singh, “Electrical Estimating and Costing”, Dhanpat Rai and Sons, ISBN 13:1234567150995.
5. SL Uppal, “Estimating and Costing”, Khanna Publishers, New Delhi.
6. J.B. Gupta, “A Course in Electrical Installation Estimating and Costing”, S.K. Kataria and Sons Reprint Edition, ISBN 10: 935014279113: 978-9350142790.
7. Bureau of Indian Standard. IS: 732-1989, Code of Practice for Electrical Wiring Installation.
8. Bureau of Indian Standard. SP-30:2011, National Electrical Code 2011.

## **SUGGESTED WEBSITES**

1. <http://swayam.gov.in>
2. <https://nptel.ac.in/>

## **INSTRUCTIONAL STRATEGY**

Teacher should identify/prepare more exercises on the pattern shown above. The teacher should make the students confident in making drawing and layouts of electrical wiring installations and doing estimation and costing leading to preparation of small tender document. This capability will lead the students to become a successful entrepreneur. Take the students to field/laboratory and show the material and equipment. Show video or animation of working of various types of wiring system and electrical transmission and distribution network. Students will use supplementary resources such as online videos, NPTEL videos, e-courses, Virtual Laboratory. This subject contains five units of equal weight age.

## 4.5 UTILIZATION OF ELECTRICAL ENERGY

<b>L</b>	<b>P</b>
<b>3</b>	<b>-</b>

### RATIONALE

This subject assumes importance in view of the fact that an electrical technician has to work in a wide spectrum of activities wherein he has to make selection from alternative schemes making technical and economical considerations; e.g. to plan and design an electrical layout using basic principles and handbooks, to select equipment, processes and components in different situations. The contents have been designed keeping the above objectives in view. Besides giving him basic knowledge in the topics concerned, attempts have been made to ensure that the knowledge acquired is applied in various fields as per his job requirements. To orient the subject matter in the proper direction, visits to industrial establishments are recommended in order to familiarize the students with the new developments in different areas

### COURSE OUTCOMES

After undergoing the subject, the student will be able to:

- CO1: Design the level of illumination based on applications
- CO2: Identify most appropriate heating and welding techniques for suitable applications.
- CO3: Illustrate the fundamentals on electrolytic and electrometallurgical processes.
- CO4: Detail electrolytic principle for various applications
- CO5: Apply principle of electric traction system & speed– time curves of different traction Systems.

### DETAILED CONTENTS

#### UNIT I

##### Illumination

Introduction, terms used in illumination, laws of illumination, indoor and outdoor illumination levels. Discharge lamps, MV and SV lamps. General ideas about time switches, street lighting, flood lighting and decorative lighting.

**UNIT II****Electric Heating & Electric Welding**

Advantages and methods of electric heating, resistance heating, induction heating, and dielectric heating. Electric welding, resistance and arc welding, electric welding equipment, comparison between A.C. and D.C, Welding.

**UNIT III****Electrolytic Processes**

Need of electro-deposition; Laws of electrolysis; process of electro-deposition - clearing, operation, deposition of metals, polishing and buffing; Principle of galvanizing and its applications; Principles of anodizing and its applications; Electroplating of non-conducting materials, Electrical Circuits used in Refrigeration and Air Conditioning and Water Coolers.

**UNIT IV****Electric Drives**

Electric Drive and its part, Advantages of electric drives, Types of electric Drives, Characteristics of different mechanical loads, Types of motors used in used in Industrial Drives, Factors affecting selection of motors, Applications of Electric Drive. Introduction to Energy efficient drives.

**UNIT V****Electrical Traction**

Advantages of electric traction, Concept of diesel electric Traction system, Systems of Track Electrification (DC & AC system), types of services – urban, sub-urban, and main line and their speed-time curves. Electrical block diagram and accessories of an electric locomotive and different accessories for track electrification such as overhead centenary wire, conductor rail system, current collector / pentagraph etc. Power supply arrangements and types of motors used for electric traction. Starting and braking of electric locomotives. Introduction to EMU and metro railways

**SUGGESTED WEBSITES**

1. <http://swayam.gov.in>
2. <https://nptel.ac.in/>

## RECOMMENDED BOOKS

1. H Partap, “Art and Science of Utilization of Electrical Energy”, Dhanpat Rai & Sons, Delhi
2. JB Gupta, “Utilization of Electrical Energy”, Kataria Publications, Ludhiana
3. Sahdev, “Utilization of Electrical Energy”, Uneek Publication, Jalandhar
4. Dr. SL Uppal, “A Text Book. of Electrical Power” Khanna Publications, Delhi
5. H Partap, “Modern Electric Traction”, Dhanpat Rai & Sons, Delhi
6. OS Taylor, “Utilization of Electrical Energy” Pitman Publications
7. CL Wadhwa, “Generation, Distribution and Utilization if Electrical Power” Wiley Eastern Ltd., New Delhi

## INSTRUCTIONAL STRATEGY

It is desired to give ample practical examples in the class while teaching this subject. Teacher must supplement his/her classroom teaching with aids such as models, charts, and video films from time to time. This subject requires demonstrations and exposure to actual workplace/industry/field. For this purpose, the subject teacher should do advance planning for visits/studies related to each topic in consultation with HOD and Principal of the polytechnic/institution. Students should be taken for visits to nearest electrified railway track and railway station to study the electric traction system. This subject contains four units of equal weight age.

## 4.6 PROGRAMMING SKILLS

L P  
- 6

### RATIONALE

Computer plays a very vital role in present day life, more so, in the professional life of Diploma engineers. In order to enable the students use the computers effectively, this course offers exposure to various engineering applications of computers in electrical engineering. The practical exercises and demonstration of application software in the field of electrical engineering during the course of study will help the students in getting the employment.

### COURSE OUTCOMES

After undergoing the subject, students will be able to:

CO1: Make and edit their own AutoCAD Drawings.

CO2: Familiarize with MATLAB programming and Simulink.

CO3: Develop a program and graphs for computations the data using Matlab.

CO4: Create user interfaces with charts, graphs, and buttons using Open Software

### DETAILED CONTENTS – CUM- PRACTICAL EXERCISES

#### UNIT I

##### Autocad Electrical

- Introduction to electrical CAD interface
- Preparing circuits using electrical components

#### UNIT II

##### Electrical Circuit Simulation (Using Qucs/Similar Open Source Application)

- Introduction to simulator interface
- Preparing Resistive circuit with voltage and current probes
- Preparing R-L circuit with voltage and current probes
- Preparing R-L-C circuit with voltage and current probes
- Preparing Diode based circuits e.g. clipper, rectifier etc.
- Preparing logic gates based circuits

**UNIT III****MyOpenLab/PyLab Works**

- Introduction to MyOpenLab
- MyOpenLab Interface
- Virtual circuit design using MyOpenLab

**UNIT IV****MATLAB/SciLab**

- Introduction to MATLAB
- MATLAB Programming – input/output, graphs, functions, loops, structures
- MATLAB programs for simple electrical circuits

**RECOMMENDED BOOKS**

1. Prof. Sham Tickoo, “Auto CAD Electrical”, BPB Publication.
2. “Auto CAD Electrical 2010 for Engineers”, Cadcim Technologies Sham, Pearson Education India.
3. Agam Kumar Tyagi, “MATLAB and SIMULINK for Engineers”, Oxford.
4. RudraPratap, “MATLAB 7”, Oxford University Press.
5. Stephen J. Chapman, “MATLAB Programming for Engineers”.
6. R.K. Bansal, and A.K. Goel, “MATLAB and Its Applications In Engineering”.

**SUGGESTED WEBSITES**

1. <http://swayam.gov.in>
2. <https://nptel.ac.in/>

**INSTRUCTIONAL STRATEGY**

The subject is totally practice oriented and requires efforts of the student to gain expertise in the programming. Students should be given enough exposure to the software and make them practice at every platform elaborately. Software installation, operation, development should also be the part of practice. The teacher should conduct viva voice of the students too.

