Government of Karnataka
Department of Collegiate and Technical Education

C-20 Second Year Diploma Curriculum
Electrical and Electronics Engineering

Curriculum Development Cell, DTE
2021-22

Government of Karnataka
DEPARTMENT OF COLLEGIATE AND TECHNICAL EDUCATION

Curriculum Structure

III Semester Scheme of Studies- Diploma in Electrical and Electronics Engineering

Sl. No.	Course Category / Teaching Department	Course Code	Course Name	Hours per week			Total contact hrs /week	Credits	CIE Marks		SEE Marks		Total Marks	Min Marks for Passing (including CIE marks)	Assigned Grade	Grade Point	SGPA and CGPA
				L	T	P			Max	Min	Max	Min					
Integrated Courses																	Both SGPA & CGPA
1	PC/EE	20EE31P	Transformers and Alternators	3	1	4	8	6	60	24	40	16	100	40			
2	PC/EE	20EE32P	Transmission and Distribution	3	1	4	8	6	60	24	40	16	100	40			
3	PC/EE	20EE33P	Switchgear and Protection	3	1	4	8	6	60	24	40	16	100	40			
4	PC/EE	20EE34P	Analog and Digital Electronics	3	1	4	8	6	60	24	40	16	100	40			
Audit Course																	
5	AU/KA	20KA31T	ಸಾಹಿತ್ಯ ಸಿಂಚನ-II/ ಬಳಕೆ ಕನ್ನಡ-II	2	0	0	2	2	50	20	-	-	50	20			
Total				**14**	**4**	**16**	**34**	**26**	**290**	**116**	**160**	**64**	**450**	**180**			

PC: Programme Core:: AU-Audit Course:: KA: Kannada:: L: Lecture:: T: Tutorial:: P: Practice

Government of Karnataka
DEPARTMENT OF COLLEGIATE AND TECHNICAL EDUCATION

Curriculum Structure

IV Semester Scheme of Studies- Diploma in Electrical and Electronics Engineering

Sl. No.	Course Category / Teaching Department	Course Code	Course Name	Hours per week			Total contact hrs /week	Credits	CIE Marks		SEE Marks		Total Marks	Min Marks for Passing (including CIE marks)	Assigned Grade	Grade Point	SGPA and CGPA
				L	T	P			Max	Min	Max	Min					
Integrated Courses																	Both SGPA & CGPA
1	PC/EE	20EE41P	Electric Motors	3	1	4	8	6	60	24	40	16	100	40			
2	PC/EE	20EE42P	Power Electronics	3	1	4	8	6	60	24	40	16	100	40			
3	PC/EE	20EE43P	Fundamentals of Automation Technology	3	1	4	8	6	60	24	40	16	100	40			
4	PC/EE	20EE44P	Computer Aided Electrical Drafting (CAED)	3	1	4	8	6	60	24	40	16	100	40			
Audit Course																	
5	KA/EE	20EE45T	Indian Constitution	2	0	0	2	2	50	20	-	-	50	20			
Total				**14**	**4**	**16**	**34**	**26**	**290**	**116**	**160**	**64**	**450**	**180**			

PC: Programme Core: AU-Audit Course:: KA: Kannada:: L: Lecture:: T: Tutorial:: P: Practice

Government of Karnataka
DEPARTMENT OF COLLEGIATE AND TECHNICAL EDUCATION

Programme	Electrical and Electronics Engineering	**Semester**	III
Course Code	20EE31P	**Type of Course**	Programme Core
Course Name	Transformers and Alternators	**Contact Hours**	8 hours/week 104 hours/semester
Teaching Scheme	L:T:P :: 3:1:4	**Credits**	6
CIE Marks	60	**SEE Marks**	40

1.Rationale:
Alternators (AC Generators) are used to generate bulk power in a power plant (Hydel, Thermal or Nuclear) Electrical Transformer is an important component in a power system used to step-up or step-down voltages for transmission and distribution. Alternators and Transformers form the core area in the field of Electrical Engineering and an Electrical Technician shall have the basic knowledge of Alternators and Transformers, viz., constructional features, operation, performance analysis, test, troubleshoot and maintenance process to be followed.

2. Course Outcomes/Skill Sets: *On successful completion of the course, the students will be able to*

CO-01	Explain all the workplace safety regulations to be followed when handling electrical machines.
CO-02	Conduct the performance analysis of transformers and alternators, draw their characteristics and determine the suitability of the given transformer and alternator for the specific application.
CO-03	List all the test parameters, testing procedure and demonstrate the testing and troubleshooting of a given transformer and alternator.
CO-04	Install a given transformer and alternator and define the various preventive maintenance processes to ensure smooth running of the transformer and alternator.

3. Course Content

Week	**CO**	**PO***	**Lecture (Knowledge Criteria)**	**Tutorial (Activity Criteria)**	**Practice (Performance Criteria)**
			3 hours/week	1 hour/ week	4 hours/week (2 hours/batch twice in a week)
1	2	1,4	1.Magnetic circuit, MMF, reluctance and mention their units, Absolute permeability and Relative permeability and mention their units, relationship between Flux, MMF and Reluctance. simple problems on magnetic circuit 2. **AC fundamentals** Concept of capacitive reactance, inductive reactance, and impedance. Current and Power in a pure resistive, inductive and capacitive circuit.	Refer Table 1	1.Simulate pure resistive, pure inductive and pure capacitive circuit and observe the phase difference between waveforms of Voltage & Current. **OR** 1a. Setup pure Inductor circuit. Measure V &I for a range of frequencies, calculate inductive reactance (Xl) and record them in a table. Plot a graph showing Xl as a function of the angular frequency . Observe the phase difference between V and I. 1b. Setup pure capacitor circuit. Measure V &I for a range of frequencies, calculate

					capacitive reactance (Xc) and record them in a table. Plot a graph showing Xc as a function of the angular frequency. Observe phase difference between V and I.
			3**.** Current, Power and Power factor of R-L, R-C, R-L-C series and parallel circuits. Concept and Applications of resonance.		2**.**Simulate R-L, R-C, R-L-C series circuits and observe the phase difference between waveforms of Voltage & Current. **OR** 2.Set up RLC circuit. a. Measure V & I for range of frequencies and record measurements in table. b. Calculate corresponding impedance (Z), power factor and record in a table. c. Plot graph of Z vs angular frequency and power factor vs angular frequency. c. Estimate resonance frequency graphically and compare with theoretical value.
2	1, 2	1,4	**TRANSFORMERS** 1**.** Basics: a. Working Principle of Transformer. b. Construction. c. Operation.	Refer Table 1	**Demonstrate workplace safety norms to be followed when handling electrical machines.** 1a**.** Identification of different types of transformers based on i. Construction ii. No. of phases iii. Application. 1b. Identification of different parts of transformer
			2. **Classification of Transformers**: a. Based on Construction b. Based on No. of phases c. Based on application **Shell and Core type**: Construction and application.		
			3**. Main Parts of Transformer**: a. Tank b. Core c. Winding d. **Insulation:** i. Oil ii. Paper e. Bushings (HT/LT/NT) f. Conservator g. OLTC (ON Load/OFF Load Tap Changers) h. Breather i**. Safety Devices**: i. Pressure Relief Device ii. Buchholz Relay j. **Instruments**: i. Oil Temperature Indicator (OTI)/Transmitter ii. Winding Temperature Indicator (WTI)/Transmitter iii. Conservator Oil level Indicator/Transmitter		**2.** Identify the terminals of a single-phase transformer, test it for open circuit, short circuit and ground faults using a test lamp /megger, check the insulation resistance, identify and locate the possible faults. Suggest remedies.
3	1, 2	1,2, 4	1. Derive emf equation, and explain transformation ratio (K). Explain Operation of a transformer on No-load with a vector diagram.	Refer Table 1	**Follow Safety rules and Safe working practices** 1a**.** Polarity test on single-phase transformer. 1b**.** Ratio test on single-phase transformer.
			2**.** Operation of a transformer On-load with vector diagrams. Draw equivalent Circuit of transformer.		

			3. Problems on emf equation, transformer on NO-load and ON-load conditions.		**2**.Determine the efficiency and regulation of a single-phase transformer by direct loading.
4	1, 2	1,4	1. **Losses in Transformer** -List Various losses in a transformer. -Voltage regulation and efficiency in the transformer. - Write an equation for voltage regulation and efficiency. -Condition for maximum efficiency. - All day efficiency. -Problem on all-day efficiency.	Refer Table 1	**Follow Safety rules and Safe working practices.** 1. Pre-determine the regulation and efficiency of a single-phase transformer by conducting O.C. and S.C. tests, draw the equivalent circuit.
			2. Pre-determine the Regulation and Efficiency of 1-ph transformer by conducting O.C. and S.C. tests.		2.Parallel operation of two single-phase transformers and analyse load sharing pattern for a given KVA rating.
			3.Necessity and conditions for parallel operation. - Parallel operation of single phase transformers with their load sharing.		
5	1, 2	1,2, 4	1.Generation of 3-ph voltage, phase sequence, Star and Delta Connection in 3-ph system, Relation between line voltage and phase voltage in 3-ph Star, Relation between line voltage and phase voltage in 3-ph Delta system. Equation for a 3-ph power	Refer Table 1	**Follow Safety rules and Safe working practices** 1. Identify the terminals of a three-phase transformer, test it for open circuit, short circuit and ground faults using a test-lamp/megger, check the insulation resistance, identify and locate the possible faults. Suggest remedies.
			2. Working principle & construction of three-phase transformers. Connection type: i. Star-Delta ii. Delta-Star iii. star-star iv. Delta-Delta v. Open delta vi. Scott.		
			3. **Vector Group** i. Brief introduction of Vector Grouping ii. Type of Vector group: a. Yy0, Dd0 b. Yd1, Dy1 c. Yd6, Dy6 d. Yd11, Dy11. Problems on 3 phase star and delta circuits.		2.Connect three single-phase transformers for three-phase operation of delta-delta/ delta-star/ star-star/ star-delta. Measure phase and line voltages.
6	2, 3	4	1. **Special purpose transformers** Construction and working of current transformer (CT). **Ref.7.2(9)**		**Follow Safety rules and Safe working practices** 1a. Identify different types of special purpose transformers. 1b. Measure high current & voltage using CT and PT.

			2. Construction, working of potential transformer (PT) 3.Construction, working of Pulse, Toroidal, Isolation transformer and Auto transformer		2a. Ratio and polarity test on CT and PT 2b. Verify the voltage of autotransformer with different tapings. **Ref.7(10,11,12)**
7	1, 2	2,4	1.Study Code of practice for selection, installation and maintenance of transformers. **IS 10028** 2. Study IS 1180 and IS 2026 standards: a. scope of IS 1180 and IS 2026 b. List transformers covered and not covered by IS 1180 c. List manufacturer of IS 1180 transformers. 3. **IEC 60071-1 to IEC 60071-12** standards for power transformers	Refer Table 1	**Follow Safety rules and Safe working practices** 1.Practice on use of IS/IEC standards. 2.Practice on use of IS/IEC standards
8	1, 3	4	1.Testing and Troubleshooting of given transformer-1 2.Testing and Troubleshooting of given transformer -2 3. Installation and Commissioning of transformer	Refer Table 1	**Follow Safety rules and Safe working practices** 1. Demonstrate testing and troubleshooting of given transformer/Visit to nearby transformer test centre **Ref.7(13)** **2.** Demonstrate installation and commissioning of Transformer.
9	1, 2	2,4	1a. Working principle and construction of DC generator. 1b**. Alternator:** working principle, Construction of salient pole and non-salient pole alternator. 2.Full pitch Armature windings and Fractional pitch Armature windings. Advantages and dis-advantages of Full pitch and Fractional pitch Armature windings. 3. Relationship between P,N,f and Derivation of emf equation, Simple problems on E.M.F equation.	Refer Table 1	**Follow Safety rules and Safe working practices** 1a. Identify parts of the DC generator and build up voltage of the shunt generator. 1b. Identify the parts of an Alternator, note down the nameplate details and interpret it. **2.** Identify the terminals, and test the field and armature windings of an Alternator for open circuit, short circuit and ground faults using test lamp /megger, check insulation resistance, Identify and locate the possible faults and suggest remedies.
10	1, 2	4	1. Armature reaction in an alternator with sketches, Effects of p.f of load on armature reaction and Effects of	Refer Table 1	**Follow Safety rules and Safe working practices**

			armature reaction on terminal voltage. 2. Procedure for conducting O.C & S.C. tests on an alternator with circuit arrangements. 3. Effective resistance, leakage reactance & synchronous reactance. Calculate the synchronous impedance by O.C. & S.C test results. Equation for the no-load terminal voltage at different power factors. Voltage regulation definition and methods.		Determine regulation of 3-phase alternator by conducting O.C & S.C tests by EMF method.
11	1, 2	4	1. Vector diagram of alternator on Load at different power factors. 2. Necessity and Conditions for parallel operation of three-phase alternators. 3. Parallel operation of three-phase alternators using synchroscope.	Refer Table 1	**Follow Safety rules and Safe working practices** Conduct parallel operation of 3-ph alternators by Dark Lamp OR Bright Lamp OR Synchroscope method.
12	1, 2	4	1. Meaning and types of excitations. Static excitation system **Ref.7(14)** 2. Effect of unequal voltage on load sharing. Effect of change in excitation and prime mover input power on distribution of load. 3. Hunting and its prevention in alternators. Necessity of cooling in alternators. Cooling agents. – Hydrogen cooling.		**Follow Safety rules and Safe working practices** 1. Demo (Video) on Static excitation system. **Ref.7(14)** 2. Demo (Video) on cooling of Alternators
13	1, 4	4	1. Maintenance of the transformer. 2. Installation and Maintenance of alternator. **Ref.7(15)** 3. Construction of an Energy efficient transformer. -Star rating of a transformer. -Benefits Of Higher Efficiency in Transformers. -Calculate Cost saving by buying an energy efficient transformer.		**Follow Safety rules and Safe working practices** 1a. Perform general preventive maintenance of the transformer. 1b. Demonstrate installation of Alternator and Perform general preventive maintenance of Alternators. **Ref.7(16)** 2a. Demo on different energy efficient transformers. 2b. Visit (or Virtual visit) to the transformer manufacturing industry.
Total in hours			**39**	**13**	**52**

***PO= Program Outcome as listed and defined in year 1 curriculum and CO-PO mapping with strength (Low/Medium/High) has to be mapped by the course coordinator. (Above only suggestive).**

Table 1: Suggestive Activities for Tutorials: (The List is only shared as an example and not inclusive of all possible activities of the course. Student and Faculty are encouraged to choose activities that are relevant to the topic and on the availability of such resources at their institution)

Sl No.	week	Activity
1	1	I. Explain the importance of resonance and its application. For a given RLC circuit. i. calculate voltage across R, L and C. ii. calculate Net Reactance. iii. calculate the resonance frequency. iv. At a given resonance frequency, calculate net reactance and voltage across L and C. II. 1. Explain Principles of induction and inductive reactance. 2. Explain self and mutual induction. 3. Explain behaviour of the inductor at low and High frequencies.
2	2	I 1. Explain Magnetic field around a current carrying conductor, Cork Screw Rule and Right-Hand Thumb Rule. 2. Explain Faraday's laws of electromagnetic induction. 3. Explain self-induced EMF and Mutually induced EMF and their application. 4. Differentiate dynamically induced and statically induced EMF. 5. Explain Lenz's law. 6. Explain Right hand and Left-hand Fleming's rule. II Study the construction of a given 1kVA transformer and identify material presently used for lamination and insulation in different types and sizes of transformer. List Differences between Aluminium and copper used as winding materials in transformers.
3	3	I. Construct and test 220/12V ,1A Step-down transformer. II. For a given single-phase transformer; 1. Calculate No-load power consumed and no-load power factor, 2. Calculate active and reactive components of No-load current 3. Draw the vector diagram for the transformer on No- load and ON-load conditions. 4. Explain the reasons for the low power factor.
4	4	I. For a given transformer 1. List the different losses in a transformer 2. Methods of reducing iron losses and copper losses. 3. Explain variations of transformer efficiency against various load power factors. 4. Explain methods to enhance the life of the Transformers. II. 1. Explain construction and working of On-load tap changing (OLTC) transformer

5	5	I For a given Star connected three-phase circuit. 1. calculate line voltage, phase voltage, line current and phase current. 2. Calculate active power, reactive power, apparent power and power factor. For a given Delta connected three-phase circuit. 1. calculate line voltage, phase voltage, line current and phase current. 2. Calculate active power, reactive power, apparent power and power factor. II 1. Explain construction of oil cooled power and distribution Transformers. 2. Explain different types of cooling used to cool the transformer. 3. Explain the properties and types of transformer oil. 4. Explain the process of transformer painting and need for painting. III 1.Explain construction of solar transformers. 2.Explain Vacuum Pressure Impregnated Transformer (VPI)
6	6	Study CT and PT 1. Compare and contrast current transformer (CT) with potential transformer (PT) 2. Explain different tests conducted on CT and PT. 3.Explain installation and commissioning of current transformer/ potential transformer. 4.Explain repair/ replacement and maintenance of CT and PT.
7	7	Study the Codes of practice IS 1180. 1. Explain Measurement of No-load Loss and Current. 2. Explain connection and phase displacement symbols for three-phase transformers 3. Rating plate details
8	8	Study the Codes of practice as per IS 10028 for selection, installation and maintenance of transformers and explain typical tests carried out before commissioning the transformer.
9	9	1. Properties of magnets and their materials, preparation of artificial magnets, significance of electromagnetism, types of cores. 2. Explain types of DC generators with circuit representation. 3. Explain Conditions for voltage build up in shunt generator.
10	10	Study harmonics generated in Generators and Transformers 1. List harmonics generated in generators and Transformers 2. Explain long term effects caused by harmonics 3. Limits and levels imposed on odd harmonics by IEC and IEEE 4. Explain how Improved winding configurations can reduce harmonics in generators
11	11	Study the latest technological changes in this course and present the impact of these changes on industry. **Study the data centre generators and** 1.List requirements for Data centre generators 2. Specifications of typical Data Centre generator 3. Method employed to reduce harmonic content 4. Protection and cooling method 5.Applicable IEC standards
12	12	Study the latest technological changes in this course and present the impact of these changes on industry. Study the Watchdog Low Temperature Rise Transformers (three-phase and single-phase) and Non-linear transformers.

		1. List the features of watchdog transformer 2. Advantages of watchdog transformer 3. Typical specification of watchdog transformer 4. List features of Non-linear transformer and its application
13	13	Study the latest technological changes in this course and present the impact of these changes on industry.

4. CIE and SEE Assessment Methodologies

Sl. No	**Assessment**	**Test Week**	**Duration** In minutes	**Max marks**	**Conversion**
1.	CIE-1 Written Test	5	80	30	Average of three tests 30
2.	CIE-2 Written Test	9	80	30	
3	CIE-3 Written Test	13	80	30	
4.	CIE-4 Skill Test-Practice	6	180	100	Average of two skill test reduced to 20
5	CIE-5 Skill Test-Practice	12	180	100	
6	CIE-6 Portfolio continuous evaluation of Tutorial sessions through Rubrics	1-13		10	10
Total CIE Marks					60
Semester End Examination (Practice)			180	100	40
Total Marks					**100**

5. Format for CIE written Test

Course Name	**Transformers and Alternators**	Test	I/II/III	Sem	III
Course Code	**20EE31P**	Duration	80 Min	Marks	30

Note: Answer any one full question from each section. Each full question carries 10 marks.

Section	Assessment Questions	Cognitive Levels	Course Outcome	Marks
I	1			
	2			
II	3			
	4			
III	5			
	6			

Note for the Course coordinator: Each question may have one, two or three subdivisions. Optional questions in each section carry the same weightage of marks, Cognitive level and course outcomes.

6. Rubrics for Assessment of Activity (Qualitative Assessment)

Sl. No.	Dimension	Beginner	Intermediate	Good	Advanced	Expert	Students Score
		2	4	6	8	10	
1		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	8
2		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	6
3		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2
4		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2
					Average Marks= (8+6+2+2)/4=4.5		**5**

Note: Dimension and Descriptor shall be defined by the respective course coordinator as per the activities

7. Reference:

Sl. No.	Description
1	Electrical Technology volume 2 - BL Theraja & A.K.Theraja S.Chand publication
2	Principles of Electrical Machines by V.K.Mehtha.S.Chand publication
3	Electrical Machines by M.N. Bandyopadhyay PHI Learning Pvt. Ltd.
4	Electrical Machines by Bhattacharya. Tata McGraw Hill Co.
5	Electrical Machines - J.B.Guptha Kataria & Sons Publications
6	Generation of Electrical Energy by BR Gupta. S.Chand Publication.
7	Fundamentals of electrical drives - G.K. Dubey Narosa publications.
8	Electrical Machines – Deshpande.
9	http://www.anuraghyd.ac.in/eee/wp-content/uploads/sites/3/power-systems.pdf
10	https://www.youtube.com/watch?v=FQ22UM0zyGs&feature=emb_logo
11	https://www.youtube.com/watch?v=mjLs40e_9YE&feature=emb_logo
12	https://relaytraining.com/wp-content/uploads/2013/07/PT-Testing_Back-to-the-Basics_RelayTraining.com_.pdf
13	https://electrical-engineering-portal.com/testing-commissioning-current-transformer
14	https://www.youtube.com/watch?v=34Fj7O_sU9I
15	https://search.abb.com/library/Download.aspx?DocumentID=SM103&LanguageCode=en&DocumentPartId=&Action=Launch
16	https://www.stamford-avk.com/sites/stamfordavk/files/AGN007_C.pdf

8.1 CIE -4 Skill Test Scheme of Evaluation:

SL. No.	Particulars/Dimension	CO	Marks
1	Portfolio evaluation of Practice Sessions(week1-week6)		10
2	List the standard safety norms related with electrical machines	1	10
3	Building and Demonstration of the working Circuit including; i. Drawing of circuit diagram using right symbols. 05 ii. Build the circuit as per the circuit diagram 10 iii. Demonstrate the performance/operation of a machine 35 iv. Document the necessary readings of the expected outcome 10	2	60
4	Viva -voce		20
	Total Marks		**100**

8.2 CIE -5 Skill Test Scheme of Evaluation:

SL. No.	Particulars/Dimension	CO	Marks
1	Portfolio evaluation of Practice Sessions (week7-week12)		10
2	List the standard safety norms related with electrical machines	1	05
3	Building and Demonstration of the working Circuit including; i. Drawing of circuit diagram using right symbols. 05 ii. Build the circuit as per the circuit diagram 05 iii. Demonstrate the performance/operation of a machine 20 iv. Document the necessary readings of the expected outcome 05	2	35
4	Explain Scope of any one IS standard (1008/1180/2026)	3	10
5	Identify the problem in a given machine and demonstrate the troubleshooting method used to rectify that problem. 10+20	3	30
6	Viva-voce		10
	Total Marks		**100**

8.3 SEE Scheme of Evaluation:

SL. No.	Particulars/Dimension	CO	Marks
1	Portfolio evaluation of Practice Sessions (1-13 week)		10
2	Building and Demonstration of the working Circuit including; i. Drawing of circuit diagram using right symbols. 10 ii. Build the circuit as per the circuit diagram 10 iii. Demonstrate the performance/operation of a machine 15 iv. Document the necessary readings of the expected outcome 05 v. Comply with the standard safety norms related with electrical machines 05	1,2	45
3	Explain the criteria for selection, the process of installation and the importance of timely maintenance and consequences for a machine for a given application 5+10+5+5	4	25
4	Viva-voce		20
	Total Marks		**100**

9. Equipment/software list with Specification for a batch of 20 students

Sl. No.	Particulars	Specification	Quantity
1	Single-phase transformer	2kVA 1:1	3
2	Single-phase transformer	2kVA 1:0.5	2
3	1-ph Variacs	(0-300)V, 5 A	6
4	3-ph Variacs	(0-440)V,15A	2
5	Potential Transformers	220V-75V	2
6	Current Transformers	5A-1A	2
7	Motor (DC Shunt,220V) and Alternator(3-ph,440V) Set		1 Set
8	Loading Rheostats	Lamp Load	2
9	Wire wound Rheostats	Assorted-range	30
10	Analog Tachometers		3
11	Digital Tachometers		3
12	Synchroscope		2
13	Phase sequence indicator		2
14	Portable DC Moving coil ammeter	multirange (0-1-2-5-10-20)	
15	Portable DC Moving coil Voltmeters	multirange (0-2-10-15-30-75-150-300V)	
16	Watt meters (Dynamometer type)	i) LPF 75/300/600V,1/2A ii) UPF 75/300/600V,5/10A iii) UPF 75/300/600V,15/30A	2
17	Frequency meters read type and digital type		2
18	Portable pf meters		
19	Megger	500 V, 1000V, 1500 V	2
20	Earth tester		2
21	Tong tester analog and digital		2 each
22	Multimeters analog and digital		4 each
23	Electrical & Electronics Circuit Simulation software PSpice/ GNU Octave/MatLab	For a batch of 20 students	

Government of Karnataka
DEPARTMENT OF COLLEGIATE AND TECHNICAL EDUCATION

Programme	Electrical and Electronics Engineering.	**Semester**	III
Course Code	20EE32P	**Type of Course**	Programme Core
Course Name	Transmission and Distribution	**Contact Hours**	8 hours/week 104 hours/semester
Teaching Scheme	L:T:P :: 3:1:4	**Credits**	6
CIE Marks	60	**SEE Marks**	40

1.Rationale:
Electric power transmission is the bulk movement of electrical energy from a power plant, to an electrical substation. Transmission network is the interconnected lines which facilitate this movement. Efficient transmission involves reducing the currents by stepping up the voltage prior to transmission, and stepping it down at a substation at the far end. Electric power distribution is the final stage in the delivery of electric power, it carries electricity from the transmission system to individual consumers through distribution substation. An Electrical Technician shall have the knowledge of the various T&D systems, components of the T&D systems and constructional features, simulate its performance, losses, distribution line maintenance and substations and shall prepare an estimation using estimation software.

2. Course Outcomes/Skill Sets: On successful completion of the course, the students will be able to

CO-01	Conduct performance analysis of a given transmission and distribution lines in a real/ simulated environment
CO-02	Describe the procedure to install, test and maintain transmission & distribution lines.
CO-03	Prepare the list of equipment/materials with specifications to install a given transmission and distribution system.

3. Course Content

Week	**CO**	**PO***	**Lecture (Knowledge Criteria)**	**Tutorial (Activity Criteria)**	**Practice (Performance Criteria)**
			3 hours/week	**1 hour /week**	**4 hours/week (2 hours/batch twice in a week)**
1	1	1,4	1.Vectorial representation of AC quantities. Represent vectors in Rectangular, Trigonometric and Polar forms, Convert Rectangular form into Polar form and vice-versa and problems on R to P and P to R. Arithmetic operations on vectors, problems	Refer Table 1	1. Measure active power, reactive power, apparent power and power factor in a single-phase/ three-phase circuit using appropriate measuring instruments. Ensure improvement of PF by use of capacitor in single-phase/three phase circuit.
			2. Concept of active power, reactive power, apparent power and power factor in AC circuit.		Introduction to simulation software

			calculate active, reactive, apparent power and power factor in a given single/ 3phase phase AC circuit. 3a. Explain KCL and KVL 3b. Explain Thevenin's and Superposition theorem, application of theorems.		1. Verify KCL and KVL using simulation software.
2	1	1,4	1.Various systems for power transmission and distribution: 2 wire AC, 3 wire AC and 3 phase 4 wire AC systems. -Simple Problems -Compare HVAC and HVDC system. **2.Line Constants and Performance:** -Classification of transmission lines based on distance. - Line constants -resistance, inductance and capacitance. -Short transmission line- equivalent circuit 3. Vector diagram of a short transmission line. -Equations for receiving end voltage, efficiency, voltage regulation and power factor. - simple problems	Refer Table 1	1.Simulate a given short transmission line-1 2. Simulate a given short transmission line-2. Find i. Sending end active and reactive power ii. Receiving end active and reactive power. iii. Voltage regulation and Transmission efficiency. compare simulation results with calculated values.**Ref.7(6)**
3	1	4	1. Skin effect, Ferrantic effect transposition of conductor and its necessity. 2. Corona: Phenomena, disruptive and visual critical voltages, corona loss. Advantages and disadvantages of corona. Methods of reducing corona. 3.Explain Transmission and Distribution losses. **Ref.7(9,10,11)**	Refer Table 1	1.Simulation of Ferranti effect. **Ref.7(7)** 2.Solve problems on Transmission and Distribution losses. **Ref.7(8)**
4	1	4	1. Main components of overhead transmission lines (Supports, Cross arms and Clamps. Insulators, Conductors., Guys and Stays., Fuses and Isolating Switches, Continuous Earth Wire etc.). 2. Characteristics and applications of ACSR, AAC, AAAC conductors, types of ACSR and	Refer Table 1	1a. Identify Different components of Overhead Transmission lines. 1b. Identify various conductors viz., All aluminium conductor (AAC), AAAC, ACSR conductor. 2. Identify HT/LT line insulators •Install the shackle type insulator on HT overhead line • Install the pin type insulator on the LT overhead line.

			their applications, compare ACSR, AAC, AAAC conductors. Insulators-suspension, Pin Type, Shackle Type, Disc Type, Guy Strain, Pins for Insulators. 3. Guy Assembly, G.I. Wire, GO Switches, 11kV Cross-arms, L.T. Line Spacers, spacing between conductor, concept of length of span, sag on overhead line, Guarding, Types of Guarding.		• fasten jumper in cross-arm of pole with pin insulator • fasten the jumper in shackle type insulator • fasten the jumper in the suspension type insulator.
5	1	4	1. **UNDERGROUND TRANSMISSION LINES**: - Classification of UG cables -General construction of a single core UG cable -Need of HT cables, advantages and disadvantages -Selection of HT and LT underground cable. 2.Construction of PVC, Construction of 3 core XLPE cables -Advantages and Disadvantages of Underground Power Cable System. 3. Scope of IS 7098-1 and IEC standards for various cables (IEC 60502-1, IEC 60502-2).	Refer Table 1	Comply with safety & IE rules while working on LT/ HT cables. 1a. Identify different types of HT/LT cables. b. Identify different parts of various underground cables. c. Select appropriate cable for given application. 2a. Practice preparation of cables for termination and joining. b. Demonstrate termination kits and practice on terminations of LT/HT cables. **Ref.7(21)**
6	1,2	2,4	1.Methods of laying UG cables. Faults in UG cable. **Cable gland-** different types of cable gland, lug, types. 2.Underground Cable Testing 3. Bonding and grounding	Refer Table 1	1a. Identify various cable single and double glands. and lugs. b. Test the underground cables for open, short circuit & ground fault and also check insulation resistance 2.Demonstrate bonding and grounding of raceways, cable assembly and panels.
7	1	4	1.**Substation:** Meaning of substation, Necessity of substation, classification, comparison between outdoor and indoor substation.	Refer Table 1	**In grid map of Karnataka** 1a. Locate 765kV, 400kV, 220kV, 110kV & 66kV Substations b. Locate 400kV, 220kV, 110kV & 66kV transmission lines. c. Locate 400kV HVDC station and Transmission line.

			2. Code of practice related to substation. List the materials required for 66/11 KV substation with their specifications **Ref.7(23,24)**		2a. Read and Interpret Single line/ Layout drawings with Equipment and Protection codes as per ANSI. 2b. Read and Interpret Layout drawings of 220kV, 110kV & 66kV outdoor substations. Interpret various panel wiring drawings of substation equipment
			3.Capacitor banks, specifications and calculation. **Ref.7(17,18, 19)** selection of capacitor bank.		
8	1	4	**Substation Energy meters:** - 1a. Error, precision, accuracy, sensitivity, resolution and tolerance. Types of errors- gross error, random error, systematic error environmental, observation error and instrumental error. 1b. Trivector energy meter Ref.7(12) **-**Common Meter Reading Instrument (CMRI) **Ref.7(14,15)** -Class of accuracy of energy meters.	Refer Table 1	1a. Demonstrate working of Trivector energy meter, Identify the class of accuracy of given energy meter. Ref.7(12) 1b. Practice on using MRI (Meter reading instrument)
			2. -Standards for electricity metering -Scope of **IS 15707** -Scope of **IEC 62052-11** -Distributed Digital Fault Recorder (DDFR). **Ref.7(16,17)**		2a. Take meter reading by using USB / Optical cable. 2b. Operation of SBM (Spot billing machine).
			3.Maintenance and up keeping of daily Log Sheet at various Substation and energy accounting.		
9	1	2,4	1. **Distribution System**: Single line diagram of AC distribution system, Classification of AC distribution system, connection schemes of distribution system- radial, ring main and interconnected systems.	Refer Table 1	Observe the various components of the **Distribution System** by visiting the MUSS and prepare report Obtain: 1. Number of feeders connected 2. Energy consumption of each feeder 3. Number of DTC meters connected 4. Percentage of distribution losses 5. 11kV Feeders Interruption Details 6. Operation of 11 kV feeders supplying power to IP sets in open delta
			2**.** Feeder, distributor and service main, characteristics of Feeder, distributor and service main.		
			3.Concept of voltage drop in feeders/distributors - simple problem on DC distributor fed at one end.		

10	1,2	2,4	**1. OPERATION OF 11KV/440V DISTRIBUTION SYSTEM**- -List Various components of the 11 kV power system (Components: e.g. transformers, Isolators, CTs, PTs, Circuit breakers, LA's, etc.) -List Various types of Panels & Substation protection systems 2a. Transformer parts and their function. 2b. Specific health and safety precautions which must be taken when carrying out substation installation processes 3.Construction of Aerial Bundled (AB) Cables, - advantages and disadvantages, - AB Cables for LT Lines. -, AB Cables for HT Lines	Refer Table 1	Observe the various components of the power system by visiting the 11 kV substation and prepare report 1. List the job requirements as per the government policies and regulations 2. Observe the various components of the power system by visiting the11kV substation (Identify various substation equipment viz., isolators, over current relays, earth fault relay, differential relay, REF relay, lightning arresters, Surge counter, wave trap, Reactor, Capacitor bank, Circuit breakers – ACB, SF-6 and VCB etc.) 3. List the materials required for the 11 kV installation 4. Observe the substation erection and installation work 5. Observe the operation of distribution transformer 6. Check the poles set to proper depth, and are properly aligned 7. Observe the erection of channel on the pole 8. Observe the fixing of lightning arrester 9. Check the installation of earth connection as per standard procedure 10. Observe the lifting Observe the lifting of the transformer, to put it on the transformer bed in a safe and efficient manner 11. Observe the connection of low voltage cables" 12. Identify Aerial bundled cables for LT and HT

11	2	2,4	**1.Maintenance schedule for distribution Transformer** a. Explain the terms inspection, preventive maintenance and overhaul. b. Explain recommended schedule for inspection of Distribution transformers. c. Explain recommended schedule for preventive maintenance of Distribution transformers. d. Explain recommended schedule for overhaul of Distribution transformers. **Ref 7(22)** **2.Maintenance schedule for 11kV overhead lines** a. Explain recommended schedule for inspection of 11kV overhead lines b. Explain recommended schedule for preventive maintenance of 11kV overhead lines c. Explain recommended schedule for overhaul of 11kV overhead lines. **Ref 7(22)** **3.Maintenance schedule for 11kV UG system** a. Explain recommended schedule for inspection of 11kV UG system b. Explain recommended schedule for preventive maintenance of 11kV UG system c. Explain recommended schedule for overhaul of 11kV UG system **Ref 7(22)**	Refer Table 1	Visit the nearby substation prepare report on 1. Maintenance schedule for distribution Transformer 2. Maintenance schedule for 11kV overhead lines 3. Maintenance schedule for 11kV UG system as per standard format
12	3	2,3	1. Prepare schedule of materials for providing single-phase OH and UG service connection for electrification of a residential building. 2.List the materials used in transmission lines with their specifications. Classify the types of towers. Prepare a table showing voltage level, ACSR conductor used,	Ref table 1	Prepare estimation manually/ using estimation simulation software

			number of discs insulators in suspension string and tension string		
			3. Prepare the schedule of materials for the 11 KV single circuit HT line for Rural Electrification."		
13	3	2,3	Estimate for Electrification of newly formed Residential Layout to an extent of 1045 KW including street light, water supply and STP installations. 1.Tapping and Extension 11KV line of (F-11) feeder of 66/11KV MUSS upto the Proposed Layout using Rabbit ACSR Conductor and 3*95 Sqmm XLPE HTUG Cable 2.Extension 11KV line Inside the Proposed Layout using Rabbit ACSR Conductor 3.Providing 11Mtrs Spun Pole Transformer Structure with allied Materials for erection of 3x250KVA and 1x100KVA 5 Star Rated Distribution Transformers on Concrete Bed. 4.Extension of LT Overhead line (3 Phase, 5Wire) inside the layout Premises and Providing Street Light Metering. 5. Calculate HT VR (voltage regulation) and LT VR.		Prepare estimation manually/ using estimation simulation software
Total in hours			**39**	**13**	**52**

***PO= Program Outcome as listed and defined in year 1 curriculum and CO-PO mapping with strength (Low/Medium/High) has to be mapped by the course coordinator. (Above only suggestive).**

Table 1: Suggestive Activities for Tutorials: (The List is only shared as an Example and not inclusive of all possible activities of the course. Student and Faculty are encouraged to choose activities that are relevant to the topic and on the availability of such resources at their institution)

Sl No.	Week	Activity
1	1	I. 1. Convert a given vector in rectangular form to polar form. 2. Convert a given vector in polar form to rectangular form. 3. Perform arithmetic operations on given vectors. II 1. solve problems on KCL and KVL 2. Solve problems on Thevenin's theorem. 3. Solve problems on the Superposition theorem. 4. calculate active, reactive, apparent power and power factor in a given single/ 3phase phase AC circuit.
2	2	Compare the relative amounts of Conductor Material in the Overhead System necessary for following systems of transmis-sion. 1.Two-Wire D.C. system with one conductor earthed 2.Single-phase 2-wire system with mid-point earthed 3.Single-phase, 3-wire system 4.Two phase, 4-wire system 5.Two-phase, 3-wire system
3	3	I. Study Process Flow Chart for Construction of Transmission Lines and 1.Explain initial survey 2.Explain detailed survey 3.Explain the Right of way 4. List the factors to be considered for selections of poles for erection of transmission lines II 1. Explain String efficiency and methods of improving string efficiency.
4	4	Study Ujwal DISCOM Assurance Yojana (a flagship scheme of the Government of India, aimed at reducing the aggregate technical and commercial (AT&C) losses of state-owned distribution companies (DISCOMs) by 6%, from 21% in FY15 to 15% in FY19) 1.Explain the methodology involved in estimating T&D losses and Aggregate Technical and commercial losses.
5	5	1.Explain Technical Specifications for 1.1 kV grade, Aluminium/Copper conductor, Power cables. 2. Explain Technical Specifications for 6.35/11 kV (Uo/U) Voltage Grade, 3-Core, 185 Sq. mm Aluminium Cable.
6	6	Explain the factors considered for selection of underground cables for a given application and list Operating limitations with cables.
7	7	Study Niranthara Jyothi Yojana (NJY) of GOK and 1.Explain the objective of this scheme 2.Benefits achieved through this yojana 3.List steps taken by government of Karnataka to flatten load curve

8	8	1.Explain Duties of shift Engineer substation. 2. Explain Testing and Commissioning of Substation DC System.
9	9	I. Study Distribution & Power Transformer Metering with condition Monitoring and Alarms 1. List the functions and specification of Distribution Transformer Metering Terminal 2. Explain how distribution transformer parameters (oil level, oil tem and winding temp. etc.) are monitored in real time. 3. List the software solution providers for Distribution & Power Transformer Metering with condition Monitoring. 4. Explain the benefits of real time monitoring of transformer
10	10	Explain commissioning of the distribution line using Aerial bunched cables.
11	11	**I Maintenance schedule for LT line and Service connection** 1. Explain recommended schedule for inspection of LT line and Service connection 2. Explain recommended schedule for preventive maintenance of LT line and Service connection. 3. Explain recommended schedule for overhaul of LT line and Service connection **II**. Study the latest technological changes in this course and present the impact of these changes on industry **Case study on "High voltage distribution system (HVDS) implementation in BESCOM**".
12	12	Study the latest technological changes in this course and present the impact of these changes on industry **Case study on "Installation of auto reclosures on 11 kV feeders in BESCOM "**
13	13	Study the latest technological changes in this course and present the impact of these changes on industry **Case study on "Reduction in Distribution Transformer failure rate in BESCOM "**

4. CIE and SEE Assessment Methodologies

Sl. No	**Assessment**	**Test Week**	**Duration** In minutes	**Max marks**	**Conversion**
1.	CIE-1 Written Test	5	80	30	Average of three tests 30
2.	CIE-2 Written Test	9	80	30	
3	CIE-3 Written Test	13	80	30	
4.	CIE-4 Skill Test-Practice	6	180	100	Average of two skill test reduced to 20
5	CIE-5 Skill Test-Practice	12	180	100	
6	CIE-6 Portfolio continuous evaluation of Tutorial sessions through Rubrics	1-13		10	10
Total CIE Marks					60
Semester End Examination (Practice)			180	100	40
Total Marks					**100**

5. Format for CIE written Test

Course Name	**Transmission and Distribution**	Test	I/II/III	Sem	III/IV
Course Code	**20EE34P**	Duration	80 Min	Marks	30

Note: Answer any one full question from each section. Each full question carries 10 marks.

Section	Assessment Questions	Cognitive Levels	Course Outcome	Marks
I	1			
	2			
II	3			
	4			
III	5			
	6			

Note for the Course coordinator: Each question may have one, two or three subdivisions. Optional questions in each section carry the same weightage of marks, Cognitive level and course outcomes.

6. Rubrics for Assessment of Activity (Qualitative Assessment)

Sl. No.	Dimension	Beginner	Intermediate	Good	Advanced	Expert	Students Score
		2	4	6	8	10	
1		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	8
2		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	6
3		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2
4		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2
	Average Marks= (8+6+2+2)/4=4.5						**5**

Note: Dimension and Descriptor shall be defined by the respective course coordinator as per the activities

7. Reference:

Sl. No.	Description
1	Transmission, distribution and utilization – vol 3 B.L Thereja and A.K.Theraja.
2	Principles of Power System" by V. K. Mehta, Rohit Mehta S. Chand Publishers, 4th Revised edition 2008
3	Electrical Power Generation Transmission and Distribution by S.N.Singh, PHI Publication
4	Transmission and Distribution of Electric Power by J.B Gupta Katsons Publications.
5	Electric Power Distribution Automation by M.K Khedkar, University Science Press (Laxmi Publications)

6	https://www.youtube.com/watch?v=Knpt6zcK CU
7	http://vp-dei.vlabs.ac.in/Dreamweaver/objective9.html
8	https://www.easycalculation.com/physics/electromagnetism/eletrical-power-transmission-line-power-loss.php
9	https://electricalnotes.wordpress.com/2014/03/01/calculate-technical-losses-of-distribution-line/
10	https://blog.se.com/energy-management-energy-efficiency/2013/03/25/how-big-are-power-line-losses/
11	https://blog.se.com/access-to-energy/2018/06/29/effective-power-distribution-and-asset-monitoring-can-shelve-off-losses-in-transformer-services/
12	https://instrumentationforum.com/t/working-principle-of-trivector-meter/6996
13	https://www.youtube.com/watch?v=ZP-Gv ERN7k, https://www.youtube.com/watch?v=SgMhJQdVONQ
14	https://dhbvn.org.in/staticContent/tender/mm/specification/spec-cmri-453.pdf
15	https://www.youtube.com/watch?v=SgMhJQdVONQ
16	https://www.aimil.com/products/digital-fault-recording-systems
17	https://www.gegridsolutions.com/multilin/catalog/ddfr.htm
18	https://www.watelectrical.com/what-is-a-capacitor-bank-working-and-its-calculation/
19	https://www.gegridsolutions.com/hvmv equipment/catalog/high volt capacitor.htm#Ov7
20	https://www.metartec.com/DataEditorUploads/R8%20-%20Capacitor%20banks%20and%20accessories.pdf
21	https://www.youtube.com/watch?v=oKhKFALKDAE
22	https://kptcl.karnataka.gov.in/storage/pdf-files/epra/mmdsystem.pdf
23	https://kptcl.karnataka.gov.in/storage/pdf-files/epra/Maintenance%20Schedule.pdf
24	https://kptcl.karnataka.gov.in/storage/pdf-files/epra/HAND%20Book%20Of%20manitenance%20Schedule%20For%20Staions%20&Transsion%20Lines.pdf
25	Electrical Design Estimating and Costing. K.B.Raina & K.Battacharya. Khanna Publications
26	Electrical Installation Estimating and Costing. J.B.Gupta, S.K.Kataria and Sons

8.1 CIE-4 Skill Test Scheme of Evaluation

SL. No.	Particulars/Dimension	CO	Marks
1	Portfolio evaluation of Practice Sessions(1-6weeks)		10
2	1.Identify Aerial Bunched Cables used in distribution systems. 2.Identify various conductors (ACSR, AAC, AAAC)	2	10
3	Demonstrate Installation of the pin type insulator on LT overhead line.	2	15
4	Test the underground cables for open, short circuit & ground fault and also check insulation resistance. 20 Explain the scope of IEC-60502-1 and IEC-60502-2 5	2	25
5	Demonstrate simulation of a given three-phase short transmission line 1. Manual calculation and simulated values (Voltage and power at the receiving end). 05+10 2. Manual calculation and simulated values (Voltage regulation and transmission efficiency). 05+10	1	30
6	Viva-voce		10
	Total Marks		**100**

8.2 CIE-5 Skill Test Scheme of Evaluation

SL. No.	Particulars/Dimension	CO	Marks
1	Portfolio evaluation of Practice Sessions (7-12 Week)		10
2	Presentation on substation visit **OR** distribution line maintenance . a. Report b. Presentation 10+20	2	30
3	Prepare estimation for the given problem manually **OR** using estimation simulation software	3	30
4	Calculate the size of capacitor bank required at given substation		10
5	Interpret given layout drawings of (220kV, OR 110kV OR 66kV) outdoor substations.	2	10
6	Viva-Voce		10
	Total Marks		**100**

8.3 SEE Scheme of Evaluation

SL. No.	Particulars/Dimension	CO	Marks
1	Report of Substation visit and Distribution line maintenance.		10
2	1.Identify different types of HT/LT cables 2. Identify the type of HT/LT line insulators 3. Identify various sizes of copper wires and cable insulation FR/FRLS/FRLSH.	2	15
3	Demonstrate termination of LT/HT cables **OR** Demonstrate cable glanding	2	35
4	Verify the case study for correct Observation and recommend suggestions for the Case on operation of **11KV/440V** distribution system. **OR** Verify the case study for correct Observation and recommend suggestions for the Case on **distribution line maintenance** 10+05	2	20
5	Viva voce		20
	Total Marks		**100**

9. Equipment/software list with Specification for a batch of 20 students

Sl. No.	Particulars	Specification	Quantity
1	Trivector energy meter		1
2	Common Meter Reading Instrument (CMRI)		1
3	Distributed Digital Fault Recorder (DDFR)		1
4	SBM (Spot billing machine)		1
5	Capacitor Banks		1
6	GNU Octave/ SCI LAB /PSCAD /MATLAB software		20
7	Electrical Estimation software		20

Government of Karnataka
DEPARTMENT OF COLLEGIATE AND TECHNICAL EDUCATION

Programme	Electrical and Electronics Engineering	**Semester**	III
Course Code	20EE33P	**Type of Course**	Programme Core
Course Name	Switchgear and Protection	**Contact Hours**	8 hours/week 104 hours/semester
Teaching Scheme	L: T:P: 3:1:4	**Credits**	6
CIE Marks	60	**SEE Marks**	40

1. Rationale:
Electrical switch gears and protective devices are the main components of power systems in any type of industry like power sector, manufacturing, process industry, hospitals, hotels, commercial buildings etc. An electrical and electronics diploma graduate should be capable of testing, commissioning, troubleshooting and maintenance of the electrical switchgears and protection devices.

2. Course Outcomes/Skill Sets: On successful completion of the course, the students will be able to

CO-01	Demonstrate the operation and testing of a given switchgear.
CO-02	Select a switchgear for a given application and list the procedures for preventive maintenance of such a switchgear to ensure it performs optimally.
CO-03	Demonstrate the testing of a protection scheme for a given power system including all its elements (alternators, transformers, bus bars and feeders).
CO-04	Identify accessories of a control panel and demonstrate the testing procedure of a given LV control panel.

3. Course Content:

Week No.	**CO**	**PO***	**Lecture (Knowledge Criteria)**	**Tutorial (Activity Criteria)**	**Practice (Performance Criteria)**
			3 hours/week Topics/subtopics	1 hour /week	4 hours/week (2 hours/batch twice in a week)
1	1	1,4	1.Meaning of Switch gear, Types-Indoor type and Outdoor type, Essential features of Switchgear, List most commonly used Switchgear equipment and Protective Devices for switching and interruption of current. Importance of power system protection and Necessity of Protective Devices.	Refer table 1	1.Identify various fuse sets viz., HRC, DO, 33KV fuse set, etc.
			2.Sources of Faults, Types of faults, Harmful Effects of short circuit current, Symmetrical and unsymmetrical faults on three-phase systems.		2a. Measure and select the appropriate size of fuse wire. 2b. Test the HRC fuse by performing a Load test.
			3.**Fuse**- Meaning, List the types of fuses with applications, Fuse Element Materials, Desirable features of Fuse elements, Characteristics of fuse. Important Terms: Current Rating of Fuse element, fusing current, fusing factor, Prospective current, cut off current, Pre-Arcing Time, Arcing Time,		

			Breaking Capacity, Total Operating Time. HRC fuses –list the types and applications, general construction and working, Merits and demerits.		
2	1	1,2,4	1.**Circuit Breaker** – Meaning, Classification of Circuit Breakers, list the types -LV, HV types with applications. Explain the terminologies – Circuit Breaker Rating, Arc-Voltage, Arching Time, Pre –Arcing Time, Prospective Current, TRV, Recovery Voltage, RRRV, Total Break Time, Making current, Breaking current, Short circuit rating and Short-time current rating. 2.Construction, working principle and applications of ELCB, RCCB, MCCB and MPCB. Concept of **ACCL** (automatic changeover with current limiter). 3.MCB- Types, Classification based on trip curves and their application, General construction and working, Characteristics of MCB.	Refer table 1	1a. Identify the various types of CB- MCB, ELCB, RCCB, MPCB and MCCB. Trace and locate MCBs used in your institution and note down their specifications. 1b. Dismantle MCCB/ELCB and identify various parts. 1c. Test the MCB and plot its inverse time characteristic curve. 2a. Troubleshooting and servicing of LT circuit breaker. 2b. Test any commercially available **ACCL.**
3	1,2	1,2,4	1.HV Circuit Breaker- working concept. ACB- Working principle, Construction, Merits, Demerits & Applications. 2.VACUUM CB- Working principle, Construction, Merits, Demerits & Applications. 3.SF6 CB- Working principle, Construction, Merits, Demerits & Applications. Concept of RMU (Ring main unit) and LBS (Load Break Switch)	Refer table 1	Visit to Substation. 1a. Identify the parts of circuit breaker and check its operation. 1b. Demonstrate test tripping characteristic of circuit breaker for over current and short circuit current. 2a. Demonstrate Installation operation and maintenance of SF6 circuit breaker, Vacuum circuit breaker. 2b. Carry out timer test on circuit breakers. 2c. Demo on RMU
4	1	1,4	1.**Protective Relay**- Definition, Types of relays, Classification of protective relaying with applications, Meaning of Primary and Back up protections, Desired qualities of Protective Relaying, General Features of protective relays. Important Terms: pick up VA, Hold-on VA, drop out VA and Burden Pickup current, current setting, PSM, TSM, Time -PSM Curve. 2.Construction. Working principle and application of Earth Leakage relay. Meaning of ZCT (Zero-Phase Current	Refer table 1	1a. Demonstrate various parts of the relay and ascertain the operation. 1b. Demonstrate setting of pick-up current/ time setting multiplier for relay operation. Ref.7(7) 2a. Test the Earth Leakage Relay. (Anyone type). 2b. Test the

			Transformers), **CBCT** (Core balance CT) - construction, working and application. 3.Construction. Working principle and application of Induction type Electro-mechanical Over Current and Overvoltage Relays. Merits and Demerits of Electro- Mechanical relays. List and explain different Testing Methods for Relays		Electromechanical over current OR **over** voltage relay.
5	1	1,4	1a. Block diagram and working of Microprocessor/ Microcontroller based Overcurrent Relay. 1b. Causes of over voltages and under voltages, Effects of OV/UV. 2a. Construction, working and application of Static relays- OV/UV relay and OCR relay. 2b. Lightning arresters & surge absorbers - Construction and principle of operation. 3a. Construction, working and applications of Numerical Relays. Comparison of Static Relays with Electro-Magnetic Relays and microprocessor/microcontroller-based relays. 3b. Concept of Multifunction Protection numerical Relays.	Refer table 1	1.Test the Static Over Voltage and Under Voltage Relay and Plot its inverse time – Voltage Characteristics. OR 1.Test static Over Current Relay (Anyone type of static relay). 2a. Program and test the Numerical Over Current/ Earth Fault Relay for Normal inverse curve for various PSM and TMS and for definite Time operations. 2b. Demonstrate multifunctional numerical relays.
6	3	1,4	**Transformer protection:** 1a. Explain Abnormalities & List different types of Faults. 1b. Construction and working of Circulating Current Scheme for Transformers Protection. Ref.7(10) 2a. Construction and working of Earth Fault or Leakage Protection Systems for Transformer. 2b. Construction and working Stator Inter Turn Protection for transformers. 3a. Construction and working of Buchholz Relay. 3b. Transformer oil – Electrical properties, desired properties and applications of Transformer oil , BDVT.	Refer table 1	1.Test the operation of Buchholz Relay. 2a. Conduct BDVT on Transformer oil. 2b. Demo on Restricted earth fault protection of Transformer.
7	3	1,4	1.Alternator Protection-Types of Protection, Explain Abnormalities and List different types of Faults. 2.Construction and working of Differential protection for Alternators.	Refer table 1	Simulate/Test Alternator protection scheme.

			3.Construction and working of Balanced Earth Fault Protection for Alternators.		
8	3	1,4	**Feeder Protection:** 1a. Explain abnormalities and list different types of Faults. 1b. Time Graded Over Current Protection on transmission line.	Refer table 1	1.Simulate/Test the operation Distance Relay.
			2a. Construction and working of Differential Pilot – Wire Protection. 2b. Discuss Basic principle of Distance Protection.		2.Simulate/Test the operation of Differential Relay.
			Bus–Bar Protection: 3a. Explain Abnormalities & List different types of Faults. 3b. Construction and working of Differential Protection of Bus -Bars.		
9	1,3		1.List Testing methods of Circuit Breaker, Explain type test and routine test & maintenance.	Refer table 1	1.Test the operation of the LV circuit breaker.
			2.List & Explain Testing methods of CT's & PT's and Maintenance of Relays.		2. Demonstrate Substation earthing.
			3.Explain Substation Earthing (Solid, Resistance and Reactance Earthing), -Neutral Earthing-Importance and types -Explain Principle and applications Peterson coil.		
10	4	2,3,4	1.Control Panel –Meaning, Types/various forms, construction of typical control panel. **Power gears-** Isolators, SFU (switch fuse unit), change over switch, selector switch.	Refer table 1	Typical low voltage power distribution panel- Identify and study the types of contactors- Power contactors and auxiliary contactors. Dis-assemble, perform preventive maintenance, service, assemble and test the contactors. Testing of control panel a. Visual test b. Insulation test c. Testing of control circuit. d. Testing of power circuit e. Conduct Logic tests
			2.Contactors – types, configuration and their specifications, various control accessories like PB switches, Indicators.		
			3.Explain various sections of control panel- Incoming section, outgoing section, busbar section.		
11	4	4	1.**Metering section** – Energy meter, Trivector meter, multi-function meter.		1.Install and test Multifunction meter.
			2.**Various auxiliary relays**: lockout, DC failure relay, TCS (trip circuit supervision relay), contact multiplier relay. -Safety interlocks.		2a. Identify and test various Auxiliary relays 2b. Demonstrate(video) Interlocking operation.
			3.Significance and importance of: IEC 61439 standards ANSI Device numbers		

12	1,4	4	1.**Motor Control Centre (MCC):** working, typical specification and application: Motor protection relay		1.Test the Motor Protection Relay.
			2a. Working, typical specification and application: Thermal Overload Relays 2b. Working, typical specification and application: Bimetal Relays -Direct / CT operated.		2.Test the operation of Thermal OLR
			3.Scope of IEC standard IEC 60947-4-1		
13	4	4	1.APFC (Automatic power Factor Control panel) - construction and working.		1.Test the operation of APFC.
			2.AMF (Automatic mains failure) panel - Construction and working.		2.Test the operation of AMF panel.
			3.STP (Standard Temperature Pressure Control) panel- Construction and working.		
Total in hours			**39**	**13**	**52**

***PO= Program Outcome as listed and defined in year 1 curriculum and CO-PO mapping with strength (Low/Medium/High) has to be mapped by the course coordinator. (Above only suggestive).**

Table 1: Suggestive Activities for Tutorials: (The List is only shared as an Example and not inclusive of all possible activities of the course. Students and Faculty are encouraged to choose activities that are relevant to the topic and on the availability of such resources at their institution).

Sl No	**Week**	**Activity**
1	1	I. Explain the Phenomena of Short Circuit and overload with the help of a general circuit diagram. II. 1. Explain various parameters considered in selecting a fuse 2. Explain specification of fuse for a particular application 3. Explain different mounting methods
2	2	Document and present 1.Selection of MCB for various applications. 2.Gradation of MCBs rating for a particular application/circuit. 3.Specifications of MCB for a particular application.
3	3	Document and present the maintenance schedule of ACB, SF6 and VCB circuit breaker.
4	4	1. Explain the specifications of ELR and Electro- mechanical over current Relay 2. Draw and explain wiring of the trip circuit of MCCB/ ACB.
5	5	1.Explain Numerical OCR wiring diagram. 2.Explain the concept of Restricted Earth fault protection. 3.Explain the concept of Voltage restrained Overcurrent relay.

6	6	Calculate Fault current at each stage of following, given Electrical System SLD having details of. 1. Main Incoming HT Supply Voltage is 6.6 KV. 2. Fault Level at HT Incoming Power Supply is 360 MVA. 3. Transformer Rating is 2.5 MVA. 4. Transformer Impedance is 6%.
7	7	1.Explain the features of the Numerical differential protection relay. 2.Explain Inadvertent/Back Energization of Generator
8	8	Study commercially available numerical Distance relay (SIPROTEC 7SA61) 1. List the features of digital Distance relay 2. List functions of digital Distance relay
9	9	Document and present on Testing and maintenance of LV Circuit Breaker, CT and PT.
10	10	Study the Metering section, Bus Bar section, CT, PT, Contactors and relays in the control panel. Draw the SLD, list the components and Write the specification of a typical control panel and its accessories. Draw the metering circuit wiring diagram. Read control panel wiring and identify ANSI codes of components.
11	11	Study the latest technological changes in this course and present the impact of these changes on industry 1. Case study on "Medium voltage (MV) switchgear "
12	12	Study the latest technological changes in this course and present the impact of these changes on industry
13	13	Study the latest technological changes in this course and present the impact of these changes on industry

4. CIE and SEE Assessment Methodologies

Sl. No	**Assessment**	**Test Week**	**Duration** In minutes	**Max marks**	**Conversion**
1.	CIE-1 Written Test	5	80	30	Average of three tests 30
2.	CIE-2 Written Test	9	80	30	
3	CIE-3 Written Test	13	80	30	
4.	CIE-4 Skill Test-Practice	6	180	100	Average of two skill test reduced to 20
5	CIE-5 Skill Test-Practice	12	180	100	
6	CIE-6 Portfolio continuous evaluation of Tutorial sessions through Rubrics	1-13		10	10
Total CIE Marks					60
Semester End Examination (Practice)			180	100	40
Total Marks					**100**

5. Format for CIE written Test

Course Name	**Switchgear and Protection**	Test	I/II/III	Sem	III/IV
Course Code	**20EE33P**	Duration	80 Min	Marks	30

Note: Answer any one full question from each section. Each full question carries 10 marks.

Section	Assessment Questions	Cognitive Levels	Course Outcome	Marks
I	1			
	2			
II	3			
	4			
III	5			
	6			

Note for the Course coordinator: Each question may have one, two or three subdivisions. Optional questions in each section carry the same weightage of marks, Cognitive level and course outcomes.

6. Rubrics for Assessment of Activity (Qualitative Assessment)

Sl. No.	Dimension	Beginner	Intermediate	Good	Advanced	Expert	Students Score
		2	4	6	8	10	
1		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	8
2		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	6
3		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2
4		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2
	Average Marks= (8+6+2+2)/4=4.5						**5**

Note: Dimension and Descriptor shall be defined by the respective course coordinator as per the activities

7. Reference:

Sl. No.	**Description**
1	Principles of Power System'' by V. K. Mehta, Rohit Mehta S. Chand, 4th revised edition 2008
2	Power System Protection and Switchgear by Buvanesh A Oza, Nirmalkumar C Nair, Rases P Mehta and Vijay H Makwana, McGraw HILL Education (India Pvt. Ltd) Newdelhi
3	J.B.Gupta "Switchgear & Protection", (edition), Katson Publisher,2008
4	MadhavaRao T.S., 'Power System Protection - Static Relays', McGraw Hill, New Delhi,2nd Edition, 21st reprinted, 2008.
5	Handbook of Switchgears by BHEL
6	Testing, commissioning, operation and maintenance of electrical equipment by Sunil S Rao, Khanna Publications
7	Protection relay: Power system protection - YouTube
8	Transmission Line Protection (21) - YouTube
9	Restricted Earth Fault Protection|REF relay working principle - YouTube

10	TRANSFORMER PROTECTION|ELECTRICAL TECHNOLOGY AND INDUSTRIAL PRACTICE - YouTube
11	MOTOR PROTECTION|PROTECTION OF INDUCTION MOTOR|ELECTRICAL TECHNOLOGY AND INDUSTRIAL PRACTICE - YouTube
12	Bus Bar Protection|Busbar Differential Protection|How busbar is protected - YouTube
13	Directional Over current relay|Protection of parallel lines|Directional over current protection - YouTube
14	Distance Protection|Transmission Line Protection|Impedance protection|Protection of line - YouTube
15	Differential protection in power transformer - YouTube
16	Protection of transformer - YouTube
17	Differential protection - YouTube
18	Transformer Differential Protection: Challenges and Solutions - YouTube
19	GENERATOR PROTECTION|PART 1|GENERATOR CONNECTION|GENERATOR EARTHING|GENERATOR FAULTS - YouTube
20	Earth Leakage Relay - ELR / How to Wire ELR & CBCT with MCCB / Working Principle of ELR - YouTube
21	Over current relay CDG 31 - YouTube
22	Smart WiFi Circuit Breaker Automatic Remote-Control Protection for Solar and any other appliances https://www.youtube.com/watch?v=m1r-78m51ds

8.1 CIE-4 Skill Test Scheme of Evaluation

SL. No.	Particulars/Dimension	CO	Marks
1	Portfolio evaluation of Practice Sessions(week1-week6)		10
2	1. Identify different types of Fuses and their applications. 2.Identify different types of LV circuit breakers and their applications	1	10
3	Demonstrate preventive maintenance of given Circuit breaker	2	20
4	Demonstrate the operation of a given Switchgear and plot its characteristics i. Drawing of the Circuit diagram using the right symbols 15 ii. Demonstrate testing of (relay/fuse/MCB) for a Given operation 30 iii. plotting the characteristics 15	1	50
5	Viva voce		10
	Total Marks		**100**

8.2 CIE-5 Skill Test Scheme of Evaluation

SL. No.	Particulars/Dimension	CO	Marks
1	Portfolio evaluation of Practice Sessions (week7-week 12)		10
2	identify and test given relay / auxiliary relay	1	10
3	Demonstration of protection scheme i. Drawing of the Circuit diagram using the right symbols 05 ii. Simulate/ Demonstrate working of protection scheme 25	3	30

4	Testing of control panel wiring in LV control panels i. Reading electrical drawings and demonstrate control panel wiring 10 ii. cable size and bus bar rating selection for given application. 10 iii. Testing control panel – Tracing control wiring, identifying components as per IEC and ANSI codes, test the components 20	4	40
5	Viva voce		10
	Total Marks		**100**

8.3 SEE Scheme of Evaluation

SL. No.	Particulars/Dimension	CO	Marks
1	Portfolio evaluation of Practice Sessions (week1- week13)		10
2	i. Selection of switch gears and its ratings for given application. ii. Selection of MCB rating and class as per applications / selection of fuse rating and type for given application.	2	10
3	Demonstrate the operation of a given Switchgear and plot its characteristics i. Drawing of the Circuit diagram using the right symbols 15 ii. Demonstrate testing of (relay/fuse/MCB) for a Given operation 30 iii. plotting the characteristics 15 **OR** Demonstration of protection scheme i. Drawing of the Circuit diagram using the right symbols 05 ii. Simulate/ Demonstrate working of protection scheme 55 **OR** Testing of control panel wiring in LV control panels i. Reading electrical drawings and demonstrate control panel wiring 15 ii. cable size and bus bar rating selection for given application. 15 iii. Testing control panel – Tracing control wiring, identifying components as per IEC and ANSI codes, test the components. 30	1/3 /4	60
4	Viva voce		20
	Total Marks		**100**

9. Equipment/software list with Specification for a batch of 20 students

Sl. No.	Particulars	Specification	Quantity
1	Different types of fuses (kit-kat fuse, cartridge fuse, glass fuse etc.) (For identification experiment)		2 no. Each
2	Single pole MCB	6 A ,220 V	6
3	Single-phase ELCB	6A ,220 V 30 mA	2
4	MCCB (for study / identification experiment only)	125 A 415V	1
5	MPCB (Motor Protection Circuit Breaker) of any low current rating (for study / identification experiment only)	3 Phase 415 V	1
6	Automatic changeover with current limiter (ACCL)		5

	Air circuit breaker		1
8	DPST and SPST knife switches or 2 pole, 3way, 6A selector switch		6
9	DPST and SPST knife switches or 2 pole, 3way, 6A selector switch	10A or 16 A or 32 A, 415 V	5
10	3 phase auxiliary contactor - any model with 2NO + 2 NC.	10 A , 415 V	5
11	Single-phase Auto transformer	Single-phase Auto transformer	6
12	Transformer (for voltage injection purpose)	240V/500V	4
13	Transformer (for current injection purpose)	240V/24V, 20A	4
14	Rheostats	45ohms 8.5 A, 100 ohms 5 A, 300 ohms 2.5 A	2
15	Thermal Overload Relay	3 Phase 415 V, 0-4.5 or 0-6 A or 0-10 A	4
16	Motor Protection Relay	3 HP, 3 Ph Induction Motor.	2
17	Digital Time Interval Meter (Digital stop watch may also be used as alternative)	0-999 ms, 0-99.9 sec, 0-99.9 min	
18	Single-phase preventer (phase failure relay)		2
19	Lock out relay with 2 NO and 2 NC (any low rating model).		2
20	Electro-mechanical Relay Trainer Kit or module with 4 mm banana pin sockets and patch cords. (TYPE - Over Load Relay or Over Voltage Relay or Under Voltage Relay or Earth Fault Relay		1 set
21	Static Relay (OLR or OVR or UVR or EFR – ANY ONE) Trainer Kit or module with 4 mm banana pin sockets and patch cords.		1 set
22	Numerical relay or Digital relay (OLR or OVR or UVR or EFR – ANY ONE)-Trainer Kit or module with 4 mm banana pin sockets and patch cords.		1 set
23	Buchholz Relay		1
24	AUX. Current source / current injection kit suitable for the above trainer kits with 4 mm banana pin sockets and patch cords.	15A	3
25	AUX Voltage source / voltage injection kit suitable for the above trainer kits with 4 mm banana pin sockets and patch cords.	220 V AC /110 V DC	3
26	Fuse and MCB testing- trainer kit		2
27	P-spice/ GNU-Octave/MatLab		20 License
27	Multifunction meter		1
28	Trivector meter	3- phase	1
29	TCS(trip circuit supervision relay 24/30/48 V DC 110-125/220-250 V DC/AC		1
30	Lock out Relay		1

Government of Karnataka
DEPARTMENT OF COLLEGIATE AND TECHNICAL EDUCATION

Programme	Electrical and Electronics Engineering	**Semester**	III
Course Code	20EE34P	**Type of Course**	Programme Core
Course Name	Analog and Digital Electronics	**Contact Hours**	8 hours/week 104 hours/semester
Teaching Scheme	L:T:P :: 3:1:4	**Credits**	6
CIE Marks	60	**SEE Marks**	40

1.Rationale:
Analog Electronic circuits are used to amplify, process and filter analog signals which are continuously variable, using amplifiers, Oscillators, switching circuits, operational amplifiers etc. Digital electronic circuits are usually made from large assemblies of logic gates. This digital logic circuitry is based on a binary system which has only two voltage levels, Low and High viz., Digital computers. Any intelligent electronic system is built by a combination of analog and digital circuits hence, it is imperative for any aspiring Technician to acquaint with the concepts of analog and digital electronics.

2. Course Outcomes/Skill Sets: *On successful completion of the course, the students will be able to*

CO-01	Identify the components of a given electronic circuit, list the uses and characteristics of the components and test the components to ensure they are in working condition.
CO-02	Use datasheets to list the alternative electronic components for a given electronic circuit ensuring the results/output remains the same.
CO-03	Build an electronic circuit for a given application and demonstrate its working either in real or a simulated environment.
CO-04	Test a given circuit for desired result/outcome, identify the problem and troubleshoot to obtain the desired result/output.

3. Course Content

Week	**CO**	**PO***	**Lecture (Knowledge Criteria)**	**Tutorial (Activity Criteria)**	**Practice (Performance Criteria)**
			3 hours/week	1 hour /week	4 hours/week (2 hours/batch twice in a week)
1	1	1,4	**ANALOG ELECTRONICS** 1.Passive components (Resistor, Inductors and capacitors): Introduction, symbols, units, types/classification, identification, selection and applications.	Refer Table 1	1a. Identify the different types of resistors. 1b. Measure the resistor values using colour code and verify the reading by measuring in the multimeter. 1c. Identify the power rating of carbon resistors by their size 1d. Identify different inductors and measure the values using LCR meter. 1e. Identify the different capacitors and measure capacitance of various capacitors using LCR meter.

			2.Semiconductors: Meaning, list semiconductor materials (Si, Ge,GaAs). -list characteristics of semiconductors. -Draw covalent bond diagram: Si, Ge, GaAs -Intrinsic Semiconductors-Two types of flow (free electrons & holes) Ref 7(1)		2a. Preparation of components, use of soldering iron and lead and flux. 2b. Standard Soldering practice to connect the components on base-board /PCB/assembly board (follow soldering standard).
			3.Doping a Semiconductor- Explain two types of Extrinsic Semiconductors (n-type and p-type). -concept of majority carrier and minority carriers. -Diode- formation, depletion region. Ref7(1)		
2	2,3	1,4	1. Diode-VI Characteristics, types, ratings and applications. Zener diode- reverse bias characteristics, voltage Regulation, shunt voltage regulator and their applications.	Refer Table 1	1a. Study and interpret data sheets of diodes and Zener diodes. 1b. Execute testing of given diode using multimeter and determine forward to reverse resistance ratio. 1c. Construct and test Zener based voltage regulator circuit.
			2.Bipolar Junction Transistors (BJT): Structure, Types, symbols, Construction, operation of (NPN/PNP) transistors. BJT Configurations, Transistor currents, alpha, beta and relationship between alpha and beta.		2a. Identify different transistors with respect to different package type, B-E-C pins, power, switching transistor, heat sinks etc b. Obtain output characteristics of BJT in CE configuration in physical mode. **OR** Simulate output characteristics of BJT in CE configuration **Ref.7(6)**
			3. CE input and output characteristics- cut off, saturation, and active regions. -Transistor biasing- definition, importance, list types. - Explain Voltage divider bias. Transistor as a switch in CE mode. -Stabilisation, thermal runaway, heat sink. **Ref.7(7).**		
3	1,3	1,4	1. FET- types. MOSFET- definition, types, symbols, N type enhancement mode- construction, working, MOSFET characteristics	Refer Table 1	1a. Identify terminals of a MOSFET and test. b. Obtain output characteristics of MOSFET in physical mode. **OR** Simulate output characteristics of MOSFET.
			2. MOSFET as switch, ratings.		2.Construct and test MOSFET application circuit (MOSFET as a switch)

			3. List applications of MOSFET, Differentiate between BJT and MOSFET		
4	3,4	1,4	1. Rectifiers- half wave, centre tapped FWR, efficiency, ripple factor, PIV. Filters- definition, necessity, C and PI filters.	Refer Table 1	1a. Identify the different types of fixed +ve and –ve regulator ICs and the different current ratings (78/79 series) 1b. Build +5V 1A DC Power Supply. **OR** Build +12V 1A DC Power Supply **Ref.7(8,9,10)**
			2. Regulated power supply- block diagram and applications. Regulator- working of 7805, mention operating voltages of 7809, 7812, 7905, 7912 Op-amp regulator, 723 regulators (Transistorized & IC based).		2a. Identify different heat sinks for IC based regulators b. Identify the parts, trace the connection and test the DC regulated power supply with safety. c. Troubleshoot and service a DC regulated power supply.
			3. Testing and Troubleshooting of Regulated Power Supply. **Ref.7(11,12)**		
5	1,3	1,4	1. Working of LED, IR LEDs, Photodiode, photo transistor and their characteristics and applications. Opto-couplers, circuits with Opto-Isolators. LASER diodes-characteristics and applications.	Refer Table 1	1a. Identify the different types of LEDs and IR LEDs. 1b. Identify optocoupler input/output terminals and measure the quantum of isolation between the terminals 1c. Construct a circuit to switch lamp load using phototransistor
			2.Amplifier- faithful amplification, classification based on configuration, power, and frequency		2. Construct and test a common emitter amplifier with and without bypass capacitors. **Ref.7(13)**
			3. Transistor CE amplifier with biasing, Working of Push pull amplifier.		
6	1,3	1,4	1. OPAMP– block diagram, operation, Characteristics, applications, µA 741 pin diagram.	Refer Table 1	1. Construct and test OP AMP as a Summer. Use an Analog IC tester to test the Analog ICs.
			2.OPAMP applications– inverting, differentiator. Integrator, summer, voltage follower, and comparator.		2. Construct and test Astable timer circuit using IC 555. Construct and test mono stable timer circuit using IC 555. **Ref.7(14)** Use an Analog IC tester to test the Analog ICs
			3. Timer– block diagram, pin diagram of IC 555, duty cycle, time-delay, Applications, A stable and Monostable multi-vibrators using IC 555.		
7	3	1,2	**DIGITAL ELECTRONICS** 1. Definitions- bit, nibble, byte, word, and parity bit. Number system- definition, types, radix, decimal, BCD, binary and hexadecimal.	Refer Table 1	1. Solve problems on number system

			2. Binary number system, Binary arithmetic: addition, subtraction, multiplication and division Complements: 1's, 2's.		2. Solve problems on conversion.
			3. Hexadecimal- addition, subtraction, Conversion- decimal to binary, decimal to hexadecimal		
8	3	1,2,4	1. Boolean variable, complement, Boolean function, expression, truth table. Boolean Algebra- rules and laws. **Ref.7(15)**	Refer Table 1	1. An electronic telephone exchange is being powered by a normal power supply. However, looking at the criticality of the exchange, a power backup generator is also installed, which can supply power in case of power failure. An alarm circuit is to be designed. There will be two LEDs (one green and the other red) on the front panel of the exchange, such that the green LED glows when power supply is available. In case of failure of power supply, the exchange draws its power from a generator, and in this case, the green LED goes OFF and the RED LED glows. In case, the generator also goes down, both green LED and red LED go OFF and a buzzer starts ringing indicating that there is a major failure. Design and implement this control circuit for both the LEDs and the buzzer.
			2.Logic gates NOT, AND, OR- definition, symbol, Boolean equation, truth table and working. Logic gates NAND, NOR, EX-OR- definition, symbol, Boolean equation, truth table and working. De Morgan's theorems- statement and equations		2. Akshay's Automated Cafeteria orders a machine to dispense coffee, tea, and milk. Design the machine so that it has a button (input line) for each choice and so that a customer can have at most one of the three choices. Diagram the circuit to ensure that the "at most one" condition is met. Implement the Circuit
			3. Karnaugh's map up to three variables- Simplification and drawing logic diagrams.		
9	1,3	1,4	1. COMBINATIONAL LOGIC CIRCUITS- Half adder- block diagram, logic diagram using AND and XOR, truth table and working.	Refer Table 1	1a. Construct Half Adder circuit using ICs and verify the truth table 1b. Construct Full adder with two Half adder circuits using ICs and verify the truth table. Use a digital IC tester to test the digital ICs
			2. Full adder- block diagram, logic diagram using AND, OR and XOR, truth table and working.		2. Construct a circuit to verify the truth table of 4:1 multiplexer using IC 74153 and 1:4 Demultiplexer using IC 74139. Use a digital IC tester to test the digital ICs
			3. Multiplexer and Demultiplexer, 4:1 MUX, 1: 4 DEMUX List real life applications of MUX and DEMUX		

10	1,3	1,4	1. Encoders and Decoders- definition, applications. Seven segment display- working	Refer Table 1	1. Construct a circuit to display 0-9 digits using standard Seven segment display with the help of decoder/ driver IC 7446/ or 7447. Use a digital IC tester to test the digital ICs.
			2. FLIP-FLOPS: S-R flip-flops, Clocked RS flip flop- block diagram, truth table, logic diagram.		2a. Identify different Flip-Flop (ICs) by the number printed on them 2b. Verify the truth tables of Flip-Flop ICs (RS, D, T, JK, MSJK) by connecting switches and LEDs.
			3. D flip- flop, JK flip-flop and T Flip-flop and Master JK flip-flop - block diagram, truth table, logic diagram.		
11	1,3	1,4	1. Shift Registers- definition, types and applications. Four-bit SISO using D Flip flops- block diagram, truth table and operation		1. Construct and test a four-bit SIPO register.
			2.Four-bit SIPO, PISO and PIPO shift registers using D flip flops- block diagram, truth table and operation.		2.Construct and test four-bit PIPO register.
			3.Counters- definition, modulus concept, timing diagram, types and applications		
12	3,4	1,4	1.Four-bit binary asynchronous counter- block diagram using JK flip flops, truth table, timing diagram and working		1. construct and test 4-bit Asynchronous binary up /down counter (IC **74LS193)**
			2. Four-bit decade asynchronous counter- block diagram using JK flip flops, truth table, timing diagram and working.		2. Rig up and test the truth table of Decade Asynchronous Counter (IC 74LS90)
			3.Three-bit synchronous up counter- block diagram, truth table, timing diagram and working.		
13	1,3	1,4	1.Digital to Analog converters: Binary weighted Resistor, DAC- block diagram and operation.		1.Construct and test (Binary weighted Resistor) Digital to Analog converter circuit.
			2. D/A converter specifications: resolution, accuracy and conversion speed. -Selection criteria for DAC		2.Construct and test the Analog to Digital converter circuit. **Ref.7(16,17)**
			3. Analog to Digital converters: Successive Approximation ADC- block diagram and operation. -Selection criteria for ADC		
Total in hours			**39**	**13**	**52**

***PO= Program Outcome as listed and defined in year 1 curriculum and CO-PO mapping with strength (Low/Medium/High) has to be mapped by the course coordinator. (Above only suggestive).**

Table 1: Suggestive Activities for Tutorials: (The List is only shared as an Example and not inclusive of all possible activities of the course. Student and Faculty are encouraged to choose activities that are relevant to the topic and on the availability of such resources at their institution)

Sl No.	Week	Activity
1	1	I 1. Explain types of inductors, construction, specifications, applications and energy storage concepts. 2. Explain types of capacitors, construction, specifications and applications. Dielectric constant. 3. Explain Capacitor behaviour with AC and DC. Concept of Time constant of a RC circuit. II. 1. Draw the atomic structure of Si, Ge, Ga and As. 2. Draw the energy level diagrams for Insulators, Conductors and Semiconductors, and list values of energy gap for Ge,Si and GaAs. 3. Draw the covalent-bond diagram for n-type and p-type material. 4. Explain the effect of donor impurities on energy band structure. 5. List the commercial applications of Ge,Si and GaAs.
2	2	I. Study datasheets of diode 1N4001-1N4007, select a diode which has peak repetitive voltage (VRRM) of 100V, RMS Reverse Voltage of 70V, Average rectified current of 1 Amp and can withstand temperature of 150 degrees Celsius. Demonstrate the appropriate method of mounting the diode or its alternatives. II. Study given Handy **Mobile Phone Charger** Circuit**,** identify components required, test the components for working condition, build circuit in a bread board and test the circuit for desired output, if desired output is not obtained, troubleshoot to obtain desired result. Demonstrate the working of a circuit in the class. III. Demonstrate troubleshooting of simple DC circuit using any simulation software.
3	3	Study given basic **LED Emergency Light** with day light sensing Circuit**,** identify components required, test the components for working condition, build circuit in a bread board and test the circuit for desired output, if desired output is not obtained, troubleshoot to obtain desired result. Demonstrate the working of a circuit in the class. Demonstrate troubleshooting of **LED Emergency Light** circuit using any simulation software.
4	4	1.Build a (0 –30) V variable output regulated power supply using IC LM317 circuit. test the circuit for desired output and demonstrate the working of circuits in the class. 2. Demonstrate the output voltage of different IC 723 metal/ plastic type and IC 78540 regulators by varying the input voltage with fixed load.
5	5	Demonstrate the operation of **Automatic Fence Lighting** Circuit with Alarm.
6	6	I. 1. Explain the criteria for selecting an appropriate Operational Amplifier for a given application. 2. Demonstrate working of OP-AMP based Peak detector 3. Demonstrate working of OP-AMP precision rectifier. List commercially available OP-AMP precision rectifiers and their applications. II. Build **Adjustable Dual Timer** Circuit using 555 Timer IC and demonstrate the working of circuit in the class.
7	7	1. Explain applications of 1s and 2s complement. 2. Explain applications of hexadecimal number system 3. Explain advantages of hexadecimal number system 4. Explain applications of BCD number system

		5. Explain limitations of BCD number system
8	8	**Two-Floor Elevator** Numerous functions must be performed by the circuitry of an elevator (open/close door, move up/down, light up/down indicator, and so on). This example focuses on one aspect of a two-floor elevator: deciding when to move to the other floor. 1. Draw the truth table for given logical conditions. 2. write the logical expression. 3. Draw the logical diagram. 4. Implement the circuit. 5. Test the circuit for all possible input conditions.
9	9	I. A committee of three Individuals decides issues for an organization. Each individual votes YES or NO for each proposal that arises. A proposal is passed if it receives at least two YES votes. Design a circuit that determines whether a proposal is passed. 1. Draw the truth table for given logical conditions. 2. Prepare K-map and deduce simplified logical expression 3. Draw the logical diagram 4. Implement the circuit. 5. Test the circuit for all possible input conditions II. **Production line control** Rods of varying length travel on conveyor belt ● Mechanical arm pushes rod within (+/- 5%) to one side ● Second arm pushes rods too long to other side ● rods that are too short stay on belt ● 3 light barriers (light source photocell) as sensors Design combinational circuit to activate arms. (Inputs are three sensors and outputs are two arm control signals)
10	10	Study **8-to-3 Bit Priority Encoder (74LS148).** 1.Explain how it can be used in magnetic positional control as used on ships navigation or for robotic arm positioning etc 2. Draw truth table for above application 3. Draw block diagram and logic diagram
11	11	1.Study the latest technological changes in this course and present the impact of these changes on industry. 2. Demonstrate basic Traffic light signal circuit using counters
12	12	Study the latest technological changes in this course and present the impact of these changes on industry.
13	13	Study the latest technological changes in this course and present the impact of these changes on industry.

4. CIE and SEE Assessment Methodologies

Sl. No	**Assessment**	**Test Week**	**Duration** In minutes	**Max marks**	**Conversion**
1.	CIE-1 Written Test	5	80	30	Average of three tests 30
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3	CIE-3 Written Test	13	80	30	
4.	CIE-4 Skill Test-Practice	6	180	100	

5	CIE-5 Skill Test-Practice	12	180	100	Average of two skill test reduced to 20
6	CIE-6 Portfolio continuous evaluation of Tutorial sessions through Rubrics	1-13		10	10
Total CIE Marks					60
Semester End Examination (Practice)			180	100	40
Total Marks					**100**

5. Format for CIE written Test

Course Name	**Analog and Digital Electronics**	Test	I/II/III	Sem	III/IV
Course Code	**20EE32P**	Duration	80 Min	Marks	30

Note: Answer any one full question from each section. Each full question carries 10 marks.

Section	Assessment Questions	Cognitive Levels	Course Outcome	Marks
I	1			
	2			
II	3			
	4			
III	5			
	6			

Note for the Course coordinator: Each question may have one, two or three subdivisions. Optional questions in each section carry the same weightage of marks, Cognitive level and course outcomes.

6. Rubrics for Assessment of Activity (Qualitative Assessment)

Sl. No.	Dimension	Beginner	Intermediate	Good	Advanced	Expert	Students Score
		2	4	6	8	10	
1		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	8
2		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	6
3		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2
4		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2
	Average Marks= (8+6+2+2)/4=4.5						**5**

Note: Dimension and Descriptor shall be defined by the respective course coordinator as per the activities

7. Reference:

Sl. No.	Description
1	Electronic Devices and Circuits theory by Robert L. Boylestad Louis Nashelsky
2	Electronics Principles by Malvino, Mc. Graw Hill, Third edition. 2000.
3	Electronics Devices and Circuits by Allen Mottershead, PHI Learning Pvt. Ltd., First Edition

4	Electronics Principles and applications by Charles A Schuler and Roger L Tokhiem, Sixth Edition, Mc. Graw Hill, 2008. 2. 3.. 4.. 5.
5	Electronics Analog and Digital by I. J. Nagrath, PHI Learning Pvt. Ltd., 2013 Edition
6	Linear Integrated Circuits by Ramakant A. Gayakwad, PHI Learning Pvt. Ltd., Fourth Edition.
7	https://www.youtube.com/watch?v=nCqQhqLTmxw
8	https://bestengineeringprojects.com/automatic-cut-off-power-supply/
9	https://www.circuitstoday.com/5v-power-supply-using-7805
10	http://www.ide.iitkgp.ac.in/Pedagogy view/example.jsp?USER ID=70
11	https://bestengineeringprojects.com/noise-free-dual-polarity-12v-power-supply-circuit/
12	https://bestengineeringprojects.com/problem-and-troubleshooting-of-power-supply/
13	https://bestengineeringprojects.com/regulated-power-supply-troubleshooting/
14	http://ee.cet.ac.in/downloads/Notes/ECLab/04-CE%20Amplifier.pdf
15	https://bestengineeringprojects.com/adjustable-dual-timer-circuit-using-555-timer-ic/
16	https://www.iitg.ac.in/cseweb/vlab/Digital-System-Lab/experiments.php
17	https://www.ti.com/lit/ds/symlink/dac0808.pdf?ts=1613370064634&ref url=https%253A%252F%252Fwww.google.com%252F
18	https://www.mepits.com/project/336/diy-projects/diy-project-digital-thermometer
19	Work sheets digital 1. https://www.liveworksheets.com/un1107740kg 2. https://nohoacsl.weebly.com/uploads/1/1/2/2/112297219/ digital electronics worksheet.pdf
20	https://inst.eecs.berkeley.edu/~ee100/su07/handouts/EE100-MultiSim-Tutorial.pdf
21	http://eceweb1.rutgers.edu/~psannuti/ece223/Manual-for-multisim.pdf

8. 1 CIE-4 & 5 Skill Test Scheme of Evaluation

SL. No.	Particulars/Dimension	CO	Marks
1	Portfolio evaluation of Practice Sessions		10
2	Visually identify the passive /active components by Code number and demonstrate if the component is in working condition	1	05
3	Identify and explain the Data Sheets for the given Electronic Devices	2	05
4	Demonstrate the working condition of components (Diode, BJT, MOSFET, Zener diode, Phototransistor, OP Amp etc.,)	3	10

5	Identify the problem in a given circuit and demonstrate the troubleshooting method used to rectify that problem. (RPS, OP Amp circuit, 555Timer circuit)	4	20
6	Building and Demonstration of the working Circuit including; i. Draw the Circuit diagram using the right symbols 05 ii. Build the circuit as per the circuit diagram 10 iii. Demonstrate the working of the circuit. 20 iv. Document the necessary readings of the expected circuit outcomes. 05	3	40
7	Viva-voce		10
Total			100

8.2 SEE Scheme of Evaluation

SL. No.	Particulars/Dimension	CO	Marks
1	Portfolio evaluation of Practice Sessions		10
2	Building and Demonstration of the working Circuit including i.Draw the Circuit diagram using the right symbols 10 ii. Identify and explain the Data Sheets of the electronic Devices. 10 iii. Demonstrate the working condition of electronics devices 10 iv. Build the circuit as per the circuit diagram 15 v. Demonstrate the working of the circuit. 20 iv. Document the necessary readings of the expected circuit outcomes. 05	1,2,3	70
3	Viva-voce		20
	Total Marks		**100**

9. Equipment/software list with Specification for a batch of 20 students

Sl. No.	Particulars	Specification	Quantity
1	DC Regulated power supply	(0-30V, 2A)	10
2	DC Regulated Dual power supply	(+/- 15V,2A)	10
3	DC Regulated Dual power supply	(+/- 5, 1A)	10
4	Cathode Ray Oscilloscope	Dual trace, 25 MHz.	10
5	Signal Generator / Function generator	(5V P-P, 200mA)	06
6	DC Voltmeter	(0-1V)	10
7	DC Voltmeter	(0-10V)	10
8	DC Voltmeter	(0-30V)	10
9	DC Ammeter	(0 -100mA)	05
10	DC Ammeter	(0 -10mA)	10
11	DC Ammeter	(0 -100mA)	10
12	Digital Multimeter-	31 /2" 06	06
13	Analog Multimeter		06
14	LCR meter		02
15	Decade resistance box	(4 Dial)	10
16	Decade capacitor box	(4 Dial)	10
17	Analog IC Trainer Kit		10
18	Digital Trainer kit		10
19	Digital IC Tester.		02
20.	Electronic Circuit Simulation Software (Multisim/Pspice/ LT spice/GNU-Octave/ MatLab-Simulink)		20

ಮೂರನೇ ಸೆಮಿಸ್ಟರ್

ಕನ್ನಡ ಬಲ್ಲ ಡಿಪ್ಲೋಮಾ ವಿದ್ಯಾರ್ಥಿಗಳಿಗೆ ನಿಗದಿಪಡಿಸಿದ ಪಠ್ಯಕ್ರಮ

(ಕನ್ನಡ ಭಾಷೆ, ಸಾಹಿತ್ಯ, ಸಂಸ್ಕೃತಿ ಮತ್ತು ಪರಂಪರೆ ಕುರಿತು)

Course Code	20KA31T	Semester : III	Course Group - AU
Course Title	**ಸಾಹಿತ್ಯ ಸಿಂಚನ – 2**	Category : Audit	Lecture Course
No. of Credits	2	Type of Course	CIE Marks : 50
Total Contact Hours	02 Hrs Per Week 26 Hrs Per Semester	Prerequisites Teaching Scheme (L:T:P)= 2:0:0	SEE Marks : Nil

ಸಾಹಿತ್ಯ ಸಿಂಚನ – 2 ಪಠ್ಯಕ್ರಮ - 20KA31T

26 ಗಂಟೆಗಳು

ಪಠ್ಯಕ್ರಮದ ಪರಿವಿಡಿ	**ಬೋಧನಾ ಅವಧಿ**
1. ಹೊಸಗನ್ನಡ ಸಾಹಿತ್ಯ ಚರಿತ್ರೆಯ ಪ್ರಭಾವಗಳು ಮತ್ತು ಪ್ರೇರಣೆಗಳು	**01 ಗಂಟೆ**
2. ಹೊಸಗನ್ನಡ ಕಾವ್ಯದ ಪ್ರಕಾರಗಳು -	**02 ಗಂಟೆ**
• ನವೋದಯ ಸಾಹಿತ್ಯ - ಲಕ್ಷಣಗಳು ಮತ್ತು ಪ್ರೇರಣೆ, ಪ್ರಮುಖ ಕವಿಗಳು ಮತ್ತು ಸಾಹಿತ್ಯದ ಕೊಡುಗೆಗಳು. • ನವ್ಯ ಸಾಹಿತ್ಯ - ಲಕ್ಷಣಗಳು ಮತ್ತು ಪ್ರೇರಣೆ, ಪ್ರಮುಖ ಕವಿಗಳು ಮತ್ತು ಸಾಹಿತ್ಯದ ಕೊಡುಗೆಗಳು. • ಬಂಡಾಯ ಮತ್ತು ಪ್ರಗತಿಪರ ಸಾಹಿತ್ಯ - ಲಕ್ಷಣಗಳು ಮತ್ತು ಪ್ರೇರಣೆ, ಪ್ರಮುಖ ಕವಿಗಳು ಮತ್ತು ಸಾಹಿತ್ಯದ ಕೊಡುಗೆಗಳು. • ದಲಿತ ಸಾಹಿತ್ಯ, ಮಹಿಳಾ ಸಾಹಿತ್ಯ, ವಿಜ್ಞಾನ ಸಾಹಿತ್ಯ ಮತ್ತು ಇತ್ತೀಚಿನ ಪ್ರಚಲಿತ ಕನ್ನಡ ಸಾಹಿತ್ಯ - ಲಕ್ಷಣಗಳು ಮತ್ತು ಪ್ರೇರಣೆ, ಪ್ರಮುಖ ಕವಿಗಳು ಮತ್ತು ಸಾಹಿತ್ಯದ ಕೊಡುಗೆಗಳು.	**03 ಗಂಟೆ** **03 ಗಂಟೆ** **03 ಗಂಟೆ** **03 ಗಂಟೆ**
3. ವೈಚಾರಿಕತೆ ಕುರಿತಾದ ಲೇಖನ - **ಜಿ ಎಸ್. ಶಿವರುದ್ರಪ್ಪ**	**01 ಗಂಟೆ**
4. ಕಥೆ - **ನೇಮಿಚಂದ್ರ**	**01 ಗಂಟೆ**
5. ಪ್ರವಾಸ ಕಥನ - **ಹಿ.ಚಿ.ಬೋರಲಿಂಗಯ್ಯ**ರವರ (ಕುಪ್ಪಳ್ಳಿ ಡೈರಿ ಪುಸ್ತಕದಿಂದ)	**01 ಗಂಟೆ**
6. ಪರಿಸರ, ವಿಜ್ಞಾನ ಮತ್ತು ತಂತ್ರಜ್ಞಾನ ಕುರಿತಾದ ಲೇಖನಗಳು	**01 ಗಂಟೆ**
7. ಪ್ರಬಂಧ - **ಗೊರೂರು ರಾಮಸ್ವಾಮಿ ಅಯ್ಯಂಗಾರ**	**01 ಗಂಟೆ**
8. ಪ್ರಚಲಿತ ವಿದ್ಯಮಾನಕ್ಕೆ ಸಂಬಂಧಿಸಿದ ಲೇಖನ - "ಪೇರು ಮಾರುಕಟ್ಟೆ ಮತ್ತು ಹಣಕಾಸು ನಿರ್ವಹಣೆ" ಕುರಿತಂತೆ	**01 ಗಂಟೆ**
9. ಕರ್ನಾಟಕ ಏಕೀಕರಣ ಚಳುವಳಿ - **ಪ್ರೊ. ಜಿ. ವೆಂಕಟಸುಬ್ಬಯ್ಯ**	**01 ಗಂಟೆ**
10. ಕನ್ನಡ ಸಿನಿಮಾರಂಗ ಬೆಳೆದು ಬಂದ ದಾರಿ ಮತ್ತು ನಾಡು-ನುಡಿ ಹಾಗೂ ನಾಡಿನ ಸಂಸ್ಕೃತಿಯ ಮೇಲೆ ಬೀರಿದ ಪ್ರಭಾವಗಳು	**01 ಗಂಟೆ**
11. ಕನ್ನಡದ ಸಾಮಾಜಿಕ ಉಪಭಾಷೆಗಳು (ಭಾಷಾ ಪ್ರಭೇದಗಳು)	**01 ಗಂಟೆ**
12. ಆಧುನಿಕ ಕನ್ನಡ ಸಾಹಿತ್ಯ ಚರಿತ್ರೆಯ ಒಂದು ಅವಲೋಕನ	**02 ಗಂಟೆ**
ಒಟ್ಟು ಬೋಧನಾ ಅವಧಿ 26 ಗಂಟೆಗಳು	**26 ಗಂಟೆ**

ಕನ್ನಡ ಬಾರದ / ಕನ್ನಡೇತರ ಡಿಪ್ಲೋಮಾ ವಿದ್ಯಾರ್ಥಿಗಳಿಗೆ ಕನ್ನಡ ಕಲಿಸಲು ನಿಗದಿಪಡಿಸಿದ ಪಠ್ಯಕ್ರಮ

Course Code	20KA31T	Semester : III	Course Group - AU
Course Title	**ಬಳಕೆ ಕನ್ನಡ – 2**	Category : Audit	Lecture Course
No. of Credits	2	Type of Course	CIE Marks : 50
Total Contact Hours	2 Hrs Per Week 26Hrs Per Semester	Prerequisites Teaching Scheme (L:T:P)= 2:0:0	SEE Marks : Nil

ಬಳಕೆ ಕನ್ನಡ – 2 ಪಠ್ಯಕ್ರಮ - 20KA31T

Table of Contents (ಪರಿವಿಡಿ) **26 ಗಂಟೆಗಳು**

ಸಾಹಿತ್ಯ ಸಿಂಚನ ಭಾಗ - II ಮತ್ತು **ಬಳಕೆ ಕನ್ನಡ ಭಾಗ - II** ಈ ಎರಡು ಪಠ್ಯಕ್ರಮಗಳಿಗೆ
CIE - ನಿರಂತರ ಆಂತರಿಕ ಮೌಲ್ಯಮಾಪನದ ಮಾರ್ಗಸೂಚಿಗಳು :

(Course Assessment and Evaluation Chart - CIE only)

Sl. No	Assessment	Type	Time frame in semester	Duration In minutes	Max marks	Conversion
1.	**CIE- Assessment - 1**	Written Test - 1	At the end of 3rd week	80	30	**Average of three written tests : 1, 2 & 3 for 30 Marks**
2.	**CIE- Assessment - 2**	Written Test - 2	At the end of 7th week	80	30	
3	**CIE- Assessment - 3**	Written Test - 3	At the end of 13th week	80	30	
4.	**CIE- Assessment - 4**	MCQ/Quiz	At the end of 5th week	60	20	**Average of three Assessment tests : 4, 5 & 6 for 20 Marks**
5	**CIE- Assessment - 5**	Open Book Test	At the end of 9th week	60	20	
6	**CIE- Assessment - 6**	Work book Consolidation & Activities	At the end of 11th week	60 (Work book Submission)	20	
Total CIE – Continuous Internal Evaluation Assessment Marks						50
Total Marks						50

ಸೂಚನೆ : 1.CIE - ನಿರಂತರ ಆಂತರಿಕ ಮೌಲ್ಯಮಾಪನದ 1, 2 ಮತ್ತು 3 ರ ಕಿರು ಪರೀಕ್ಷೆಗಳನ್ನು ಮತ್ತು ಮೌಲ್ಯಮಾಪನದ 4, 5 ಮತ್ತು 6 ರ ಪರೀಕ್ಷೆಗಳನ್ನು ಪ್ರತ್ಯೇಕ ಬ್ಲೂಬುಕ್ ಪುಸ್ತಕದಲ್ಲಿ ವಿದ್ಯಾರ್ಥಿಗಳು ಬರೆಯಬೇಕು.

2.ಸೆಮಿಸ್ಟರ್ ಅಂತ್ಯದಲ್ಲಿ ವಿದ್ಯಾರ್ಥಿಗಳು, ತರಗತಿ ಕನ್ನಡ ಭಾಷಾ ಶಿಕ್ಷಕರಿಂದ ಮತ್ತು ವಿಭಾಗಾಧಿಕಾರಿಗಳಿಂದ ದೃಢೀಕರಣಗೊಂಡ ಕಾರ್ಯಪಠ್ಯಪುಸ್ತಕವನ್ನು (Work Book) ಮೌಲ್ಯಮಾಪನ ಭಾಗ-**CIE- Assessment – 6** ರ ಪರೀಕ್ಷೆಯ ನಂತರ ಆಯಾ ವಿಭಾಗಕ್ಕೆ ಸಲ್ಲಿಸಬೇಕು.

4th SEMESTER

Government of Karnataka
DEPARTMENT OF COLLEGIATE AND TECHNICAL EDUCATION

Programme	Electrical and Electronics Engineering	**Semester**	IV
Course Code	20EE41P	**Type of Course**	Programme Core
Course Name	Electric Motors	**Contact Hours**	8 hours/week 104 hours/semester
Teaching Scheme	L:T:P :: 3:1:4	**Credits**	6
CIE Marks	60	**SEE Marks**	40

1. Rationale:

Electric motors impact almost every aspect of modern living through the use of various Appliances. They are used at some point in the manufacturing process of nearly every conceivable product that is produced in modern factories and has nearly unlimited number of applications. An Electrical Technician is expected to Analyse the performance and select a particular motor for an application followed by testing, troubleshooting and maintenance of the same.

2. Course Outcomes/Skill Sets:

On successful completion of the course, the students will be able to

CO-01	Conduct performance analysis of a given electrical motor, draw its characteristics and determine the right motor for a specific application.
CO-02	Select, Install and test the motor to be used for a specific application.
CO-03	Describe test parameters, testing procedures and demonstrate the troubleshooting of a given electric motor to ensure it performs optimally.
CO-04	Construct power circuit and control circuits using appropriate components /devices to control the given electric motor.

3. Course Content

Week	**CO**	**PO***	**Lecture (Knowledge Criteria)**	**Tutorial (Activity Criteria)**	**Practice (Performance Criteria)**
			3 hours/week	1 hour /week	4 hours/week (2 hours/batch twice in a week)
1	1	1,4	1. **DC Motors:** Working principle, back emf & voltage equation- simple problems.	Refer Table1	**Follow Safety rules and Safe working practices (Demo)** 1. Identify the terminals, and test the field and armature windings of a DC machine for open circuit, short circuit and ground faults using test lamp /megger, check the insulation resistance, identify and locate the possible faults.
			2. Types of motor-circuit diagram with voltage equation. -meaning of Torque -torque developed by D.C motors, torque equation [no derivation] -torque- speed relationship		2. Control the Speed of the DC shunt motor by Armature voltage control. Plot the graph.
			3a. Characteristics of D.C. Motors -Torque – Speed, Speed – Load and Torque – Load Characteristics. 3b. Methods of speed control: – shunt field control –Armature or Rheostatic control		

			-Voltage control		
2	1	1,2,4	1. **Induction Motors**: Working principle of induction motor. Rotating magnetic field produced by polyphase supply.	Refer Table1	**Follow Safety rules and Safe working practices** 1a. Identify the parts of the 3-phase squirrel cage induction motor, test it for open circuit, short circuit and ground faults using a test lamp / megger, check the insulation resistance, identify and locate the possible faults. Suggest remedies. 1b. Connect forward & reverse a 3-phase squirrel cage induction motor.
			2. Construction of stator, squirrel cage rotor and phase wound rotor. Slip, frequency of rotor current. Problems.		2a. Identify the parts of 3 phase slip ring induction motor, test it for open circuit, short circuit and ground faults using test lamp/megger, check the insulation resistance, identify and locate the possible faults. Suggest remedies. **Ref.7(5)** 2b. Connect forward & reverse a 3-phase slip ring induction motor.
			3. Starting torques of squirrel cage and slip ring induction motor with expression. Condition for max starting torque. Effect of change in supply voltage on starting torque.		
3	1	1,4	1. Equation for torque under running conditions. -Draw torque – slip curves. -Relationship between full load torque and maximum torque, starting torque and maximum torque	Refer Table1	**Follow Safety rules and Safe working practices** 1. Plot the Speed-Torque (Slip Vs Torque) Characteristics of 3-Phase Induction motor by mechanical loading (Brake-drum apparatus). Use Power Quality Analyzer & Motor Analyzer to measure various parameters. **Ref.7(6)**
			2. Explain Equivalent circuit of an induction motor.		
			3. Relationship between rotor power input, rotor copper loss, and Mechanical power developed and slip. -Problems on the above.		2. Determine the efficiency of 3-phase squirrel cage induction motor by no load test/ blocked rotor test and brake test. Use Power Quality Analyzer & Motor Analyzer to measure various parameters.
4	1	1,4	1. **Starters:** Necessity of starters and list the various types of starters. Main criteria for the selection of the starting method.	Refer Table1	1a. Identify the parts of a DOL starter, test its parts, locate faults if any. Suggest remedies.

			2a. Construction, working and troubleshooting of D.O.L. Starter. 2b. Construction, working and troubleshooting of star-delta Starter.		1b. Connect, Start, Run and Reverse the direction of rotation of 3-phase Induction Motor using DOL starter. **Ref.7(7)**
			3a. Construction and working of Soft Starter. 3b. Maintain, service and troubleshoot the AC motor starter		**Follow Safety rules and Safe working practices.** 2a. Identify the parts of a Star-Delta starter, test its parts and locate faults if any. Suggest remedies Trace the start terminals and end terminals of three-phase windings and mark the terminals u1,v1,w1 and u2,v2,w2 Connect, Start, Run and Reverse the direction of rotation of 3-phase Induction Motor using star delta starter. 2b. Maintain, service and troubleshoot the AC motor starter
5	1,3	2,4	1. Speed Control of induction motor: - Change of applied voltage method. - Change of number of poles.	Refer Table1	**Follow Safety rules and Safe working practices.** 1. Speed control of IM using any one method, Use of Power Quality Analyzer & Motor Analyzer to measure various parameters.
			2. Speed Control of induction motor: - Change of frequency - Rheostat control method.		2a. Testing, troubleshooting and Servicing of three-phase Induction motors. 2b. Perform general preventive maintenance on 3-ph Induction motor. **Ref.7(8,9,10,11)**
			3. Testing and troubleshooting procedure of three-phase Induction motor. -General preventive maintenance procedure of three-phase Induction motors.		
6	1	1,4	1. **Synchronous Motors**: Working principle, construction, and method of starting of synchronous motor. -Compare the synchronous motor with the induction motor.	Refer Table1	**Follow Safety rules and Safe working practices** 1. Start, Run and Reverse the direction of rotation of the synchronous motor.
			2.Effect of increased load with constant excitation. - Effect of change in excitation at constant load.		2. Plot V and inverted V curves for synchronous motor, Use Power Quality Analyzer & Motor Analyzer.
			3. Effect of excitation on armature current & power factor.		

7	1	1,2,4	1. Effect of excitation on leading, lagging and zero power factor. 2. Synchronous condenser and its application. **Ref.7(19).** 3. Hunting and phase swinging, losses and methods of starting of synchronous motors.	Refer Table1	1. Demonstrate troubleshooting of synchronous motors. 2. Case study of Synchronous condenser.
8	1,2	1,4	1. IEC/ NEMA motors, Enclosure protection classes available protection classes are IP23, IP44, IP54 -IEC 60034-4-1:2018 standard for synchronous motors. 2. Synchronous reluctance motors. **Ref.7(22).** 3. Procedure for Installation and Maintenance of sync motors and Induction motor.	Refer Table1	1. Demonstrate different protection classes. 2a. Demonstrate Installation of synchronous motor and Induction motor. 2b. Perform general preventive maintenance of sync motors. **Ref.7(20,21)**
9	1	1,4	1. **Single-phase motors:** Working principle, construction and characteristics. **Ref.7(28).** 2. Resistance Split phase motor -Capacitor Start Induction motor. 3. Working Principle & characteristics of Induction Generators and its applications.	Refer Table1	1a. Identify and connect the starting winding, running winding, capacitor centrifugal switch terminals rotation of 1-ph capacitor start Induction Motor. 1b. Start, Run and Reverse the direction of rotation. 2. Perform general preventive maintenance of 1-ph Induction Motors.
10	1	1,4	1. **Special Machines:** **Servo motor:** Working, construction and applications, types, speed-torque characteristics, specifications, control mechanism. **Ref.7(29).** Working, construction and applications of Stepper motor and Torque motor and spindle motor. 2. Working, construction and applications of Universal motor, Reluctance Motor, Permanent Magnet Synchronous Motor (PMSM). 3. Working, construction and applications of Two phase Four Pole Permanent magnet motor, Brushless D.C. Motors, specification for EV motors. **Ref.7(31)**	Refer Table1	1.Identify the parts of special machines: Servo motor, universal motor, stepper motor and brushless DC Motor, and test the coils and windings for its working condition. 2. Demonstrate applications of special machines.
11	2,4	2,3	1. Industrial application of motors.	Refer Table1	1. Calculate the total system efficiency by combining the four key components of a motor

			-Select a motor for a given industrial application. **Ref.7(12,13,14)**		system: the motor, drive, transmission and load (e.g., pump, fan, compressor, etc.) by using a motor testing tool(software). **Ref.7(15,16,17,18)**
			2 Motor testing tool for energy efficiency. **Ref.7(25,26,27)**		2.Identify different types of push button switches- single element and two element ON/OFF switches, mushroom head emergency stop switch, illuminated type, key lock type, selector switches and limit switches.
			3. Draw the standard symbols of control components Different types of push button switches- single element and two element ON/OFF switches, mushroom head emergency stop switch, illuminated type, key lock type, selector switches and limit switches.		
12	4	3,4	1. Working principle of Bi-metallic Overload Relay, Time Delay Relays - Electronic timer and electro-mechanical Pneumatic timer and Single-Phase preventer. **Ref 7(32)**		1a. Identify Bi-metallic Over Load Relay, Time Delay Relays - Electronic timer and Electro-mechanical Pneumatic timer and Single-Phase preventer. 1b. Identify the parts of a contactor, number of NOs, NCs, nature of coil supply AC/DC, voltage ratings and current ratings. Note down the technical specifications and terminal identification number
			2.Parts of a contactor, number of NOs, NCs, nature of coil supply AC/DC, voltage ratings and current ratings.		2a. Rig up and test the following applications of logic gates using push button switches, contactor and indicators. a) Starting from two different locations (OR Function) b) Stopping from one position (NOT Function) c) Two hand operation (AND Function) d) Stopping from two different locations (NOT+OR or NOR Functions) e) Stopping if both signals are given (NOT+AND or NAND functions) f) Memory function (Signal is maintained or holding). h. XOR and XNOR operation. 2b. Rig up and test Direct On Line Starter. **Ref 7(33)**
			3.Draw a control circuit for DOL starter and control circuit for forward and reverse operation of a motor with interlocking function using auxiliary contact.		
13	4	3,4	1.Draw a control circuit for forward and reverse operation of a motor with interlocking function using combined auxiliary contact and push buttons.		1.Rig up and test the control circuit for forward and reverse operation of a motor with interlocking function using combined auxiliary contact and push buttons.

			2.Draw a control circuit for a semi-automatic star delta starter. 3.Draw a control circuit for a fully automatic star delta starter.		2.Rig up and test the control circuit for a fully automatic star delta starter. **Ref 7(34)**
Total in hours			**39**	**13**	**52**

***PO= Program Outcome as listed and defined in year 1 curriculum and CO-PO mapping with strength (Low/Medium/High) has to be mapped by the course coordinator. (Above only suggestive).**

Table 1: Suggestive Activities for Tutorials: (The List is only shared as an example and not inclusive of all possible activities of the course. Students and Faculty are encouraged to choose activities that are relevant to the topic and on the availability of such resources at their institution).

Sl No	Week	Activity
1	1	Study the construction of a given DC motor and identify material presently used for construction of YOKE, poles and field winding, armature winding and brushes.
2	2	Compare and contrast Induction motor with Transformer.
3	3	Study Low voltage General performance cast iron motors and 1. Explain IEC 60034-30-1:2014 standard 2. List the motors covered in IEC 60034-30-1:2014 standard 3. List the motors excluded from IEC 60034-30-1:2014 standard 4. Explain the four International Efficiency (IE) classes 5. Explain mounting and cooling arrangements 6. Degrees of protection: IP code 7. Explain thermal classes (B, F and H) and insulation class 8. Tabulate and present Minimum 50 Hz efficiency values defined in IEC/EN 60034-30-1:2014 (based on test methods specified in IEC 60034-2-1:2014)
4	4	Study soft starter 1. Explain how soft starter improves performance in Pumps, fans, conveyors and compressors 2. Compare different starting methods (DOL, Star Delta and Soft starters) and explain problems which are prevented using soft starters. 4. Explain the selection process involved in selecting the right soft starters for a given application. 5. Explain the benefits of soft starters. 6. Typical Technical specification of soft starter. 7. Explain Circuit diagram of any soft starter.
5	5	Study V/f method of speed control and 1. Explain V/f method of speed control 2. List Advantages of V/f method
6	6	Compare synchronous motor with Induction motor
7	7 & 8	Study given synchronous motor 1. List applications of synchronous motor 2. Explain fixed speed and variable speed Synchronous motors 3. List applications of fixed speed and variable speed Synchronous motors 4. Explain Methods of cooling

		5. Explain the Excitation method for a given application.
8	9	Study Totally enclosed squirrel cage single-phase low voltage motors, Sizes 56 - 100, 0.065 to 2.2 kW. 1. Explain CSR (capacitor start and run), PSC (run capacitor) and PSC-regulation 2. Typical Specification of PSC motor, CSR and PSC -regulation 3. Explain Cooling system, insulation class and mounting arrangements
9	10	Study electric motors used in Electric vehicles. 1. List the motors used in Electric vehicles 2. Explain speed -torque characteristics of Each motor. 3. Explain Electrical specifications of each motor 4. List the company's manufacturing Four-wheeler and Two-wheeler EV
10	11	Study the case "World's largest multi-stage water pumping stations project designed to bring much needed water to the Indian state of Telangana. " 1. List Type and size of motors used in the project 2. Quantity of water lifted daily in TMC 3. Size of pumps used to lift water 4. Total power required for the project https://new.abb.com/drives/media/kaleshwaram-lift-irrigation-system-abb-success-story https://www.youtube.com/watch?v=5wXOSVCHf38
11	12	Study the case "Mahatma Gandhi Kalwakurthy Lift Irrigation Scheme " 1. List Type and size of motors used in the project 2. Quantity of water lifted daily in TMC 3. Size of pumps used to lift water 4. Total power required for the project https://new.abb.com/news/detail/4291/abb-pumping-technology-helps-rescue-parched-farms-and-villages-in-india
12	13	Study the latest technological changes in this course and present the impact of these changes on industry.

4. CIE and SEE Assessment Methodologies

Sl. No	**Assessment**	**Test Week**	**Duration** In minutes	**Max marks**	**Conversion**
1.	CIE-1 Written Test	5	80	30	Average of three tests 30
2.	CIE-2 Written Test	9	80	30	
3	CIE-3 Written Test	13	80	30	
4.	CIE-4 Skill Test-Practice	6	180	100	Average of two skill test reduced to 20
5	CIE-5 Skill Test-Practice	12	180	100	
6	CIE-6 Portfolio continuous evaluation of Tutorial sessions through Rubrics	1-13		10	10
Total CIE Marks					60
Semester End Examination (Practice)			180	100	40
Total Marks					**100**

5. Format for CIE written Test

Course Name	**Electric Motors**	Test	I/II/III	Sem	III/IV
Course Code	**20EE41P**	Duration	80 Min	Marks	30

Note: Answer any one full question from each section. Each full question carries 10 marks.

Section	Assessment Questions	Cognitive Levels	Course Outcome	Marks
I	1			
	2			
II	3			
	4			
III	5			
	6			

Note for the Course coordinator: Each question may have one, two or three subdivisions. Optional questions in each section carry the same weightage of marks, Cognitive level and course outcomes.

6. Rubrics for Assessment of Activity (Qualitative Assessment)

Sl. No.	Dimension	Beginner	Intermediate	Good	Advanced	Expert	Students Score
		2	4	6	8	10	
1		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	8
2		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	6
3		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2
4		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2
	Average Marks= (8+6+2+2)/4=4.5						**5**

Note: Dimension and Descriptor shall be defined by the respective course coordinator as per the activities

7. Reference:

Sl. No.	Description
1	Electrical Technology volume 2 - BL Theraja & A.K.Theraja S.Chand publication.
2	Principles of Electrical Machines by V.K.Mehtha.S.Chand publication.
3	Electrical machines - Theory and Practice by M.N. Bandyopadhyay PHI publication.
4	Electrical Machines by Bhattacharya. Tata McGraw Hill Co. 5. Electrical Machines - J.B.Guptha Kataria & Sons Publications
5	https://search.abb.com/library/Download.aspx?DocumentID=9AKK107991A3212&LanguageCode=en&DocumentPartId=&Action=Launch

6	https://search.abb.com/library/Download.aspx?DocumentID=B5.0205&DocumentPartID=&Action=Launch
7	https://new.abb.com/docs/librariesprovider53/about-downloads/low-voltage-motor-guide.pdf
8	https://assets.new.siemens.com/siemens/assets/api/uuid:8e9204f9-1860-4720-9d6b-2be548d915d0/version:1560800077/troubleshooting-induction-motors.pdf
9	https://www.youtube.com/watch?v=390nOrLHAaw&t=3176s
10	https://www.youtube.com/watch?v=BoFToRcfL0k
11	https://www.youtube.com/watch?v=VCtiehg2pZc
12	h https://motors-pumps.gainesvilleindustrial.com/category/all-categories-electric-motor
13	https://www.controleng.com/online-courses/how-to-specify-motors-for-more-efficient-hvac-systems/
14	https://www.controleng.com/articles/how-to-select-a-motor-for-an-industrial-application/#:~:text=There%20are%20many%20aspects%20to,or%20a%20servo%2Fstepper%20motor.&text=Requirements%20for%20controlling%20motor%20speed%20and%20position%20also%20need%20to%20be%20considered.
15	https://www.iea-4e.org/wp-content/uploads/publications/2015/09/1 emsa pb 20150917.pdf
16	https://www.iea-4e.org/emsa/our-work/emsa-tools/
17	https://www.iea-4e.org/wp-content/uploads/2020/11/quickguide-mst-tool 1.2.pdf
18	https://www.iea-4e.org/wp-content/uploads/2020/11/webinar-2-motor-systems-tool 20151015.pdf
19	https://search.abb.com/library/Download.aspx?DocumentID=9AKK107991A6324&LanguageCode=en&DocumentPartId=&Action=Launch
20	https://search.abb.com/library/Download.aspx?DocumentID=SM103&LanguageCode=en&DocumentPartId=&Action=Launch
21	https://search.abb.com/library/Download.aspx?DocumentID=3BSM900636&LanguageCode=en&DocumentPartId=&Action=Launch
22	https://library.e.abb.com/public/58b63ea623dddaf9c125786800278df5/56-61%201m103 ENG 72dpi.pdf
23	https://www.youtube.com/watch?v=mgoZSL2u6Jw
24	https://www.se.com/in/en/work/solutions/motor-control-protection/
25	https://www.iea-4e.org/wp-content/uploads/2020/11/MST Example I - anno 2017.pdf

26	https://www.iea-4e.org/wp-content/uploads/2020/11/MST Example II - anno 2017.pdf
27	https://www.iea-4e.org/wp-content/uploads/2020/11/MST Example II - anno 2017 Solution.pdf
28	https://search.abb.com/library/Download.aspx?DocumentID=B5.0205&DocumentPartID=&Action=Launch
29	https://www.motioncontrolonline.org/blog-article.cfm/What-is-a-Brushless-DC-Motor-and-How-Does-It-Work/57
30	https://www.motioncontrolonline.org/blog-article.cfm/What-is-a-Brushless-DC-Motor-and-How-Does-It-Work/57
31	https://circuitdigest.com/article/different-types-of-motors-used-in-electric-vehicles-ev
32	https://www.youtube.com/watch?v=2hsHoMEuS-0
33	https://www.youtube.com/watch?v=AhJRHFfXkdg
34	https://www.youtube.com/watch?v=OtydNtCxYQI

8.1 CIE-4 Skill Test Scheme of Evaluation

SL. No.	Particulars/Dimension	CO	Marks
1	Portfolio evaluation of Practice Sessions (week1-week6)		10
2	List the standard safety norms related to electrical motors.	1	10
3	Building and Demonstration of the working Circuit including; i. Drawing of circuit diagram using right symbols 10 ii. Build the circuit as per the circuit diagram 10 iii. Demonstrate the performance/operation of a motor 25 iv. Document the necessary readings of the expected outcome 05	1	50
4	Identify the problem and demonstrate the troubleshooting method used to rectify that problem in a motor.	3	20
5	Viva-voce		10
	Total Marks		**100**

8.2 CIE-5 Skill Test Scheme of Evaluation

SL. No.	Particulars/Dimension	CO	Marks
1	Portfolio evaluation of Practice Sessions (week7-week12)		10
2	List the standard safety norms related to electrical motors.	1	10
3	Building and Demonstration of the working Circuit including; i. Drawing of circuit diagram using right symbols 05 ii. Build the circuit as per the circuit diagram 10 iii. Demonstrate the performance/operation of a motor 15 iv. Document the necessary readings of the expected outcome 05	4	35
4	Explain the criteria for selection, the process of installation and the importance of timely maintenance and consequences for a motor.	2	15
5	Identify the problem and demonstrate the troubleshooting method used to rectify that problem in a motor.	3	20
6	Viva-voce		10

	Total Marks		**100**

8.3 SEE Scheme of Evaluation

SL. No.	Particulars/Dimension	CO	Marks
1	Portfolio evaluation of Practice Sessions (week7-week12)		10
2	Building and Demonstration of the working Circuit including; i. Drawing of circuit diagram using right symbols 10 ii. Build the circuit as per the circuit diagram 10 iii. Demonstrate the performance/operation of a motor 20 iv. Document the necessary readings of the expected outcome 05 v. Comply with standard safety norms related to electrical motors 05	1 / 4	50
3	Identify the problem in given motor and demonstrate the troubleshooting method used to rectify that problem in a motor.	3	20
4	Viva-voce		20
	Total Marks		**100**

9. Equipment/software list with Specification for a batch of 20 students

Sl. No.	Particulars	Specification	Quantity
1.	Central distribution board with control gear and power supply panel for all M/C.		One
2.	Static converter Input-3phase, 440V,50Hz. Output -15kW,0-220V Continuously variable.		One set
3.	DC Shunt Motor with mechanical loading (a brake drum) apparatus		One Set
4	3-Phase Squirrel Cage Induction motor with mechanical loading (a break drum) apparatus		Two set
5	Synchronous motor		One set
6	1-phase Capacitor start Induction motor		One set each
7.	F.HP-motors Universal/hysteresis stepper motor, brushless DC motor, stepper motor, spindle motor , Permanent magnet synchronous motor, Reluctance motor		One each
8	1-Phase Variacs	220V,5A	2
9	3-Phase Variacs	440V,15A	3
10	Single-phase IM Various types one in each type		One each
11	Voltmeters	0-300/600 VAC	
12	Ammeters	0-5/10a AC	
13	Power Quality Analyser and Motor analyser		1
14	Motor Testing Tool free software (https://www.iea-4e.org/emsa/our-work/emsa-tools/)		
15	Contactor - 16A, 4POLE, Coil Voltage 220volts/50 hz AC With 2 NO + 2 NC		20
16	Timer (Electronic) 10 NO		10
17	Push button (ON) 2 element type (1 NO + 1 NC)		20
18	Push button (OFF) 2 element type (1 NO + 1 NC)		20
19	Different types of Push button Switches (key type, Illuminated type, Emergency trip mushroom head type		5 Each
20	Limit Switches		20
21	Selector Switches		20
22	Thermal Over load relays (0-16A,415V with 1NO+1NC)		20
23	MCB 16A, 415V, 4pol		10

Government of Karnataka
DEPARTMENT OF COLLEGIATE AND TECHNICAL EDUCATION

Programme	Electrical and Electronics Engineering	**Semester**	IV
Course Code	20EE42P	**Type of Course**	Programme Core
Course Name	Power Electronics	**Contact Hours**	8 hours/week 104 hours/semester
Teaching Scheme	L:T:P :: 3:1:4	**Credits**	6
CIE Marks	60	**SEE Marks**	40

1.Rationale:
Power electronics is the application of solid-state electronics to the control and conversion of electric power. Power semiconductor devices are used to construct converters and inverters in the various applications such as power supplies, Electric drives, Flexible AC Transmission systems and Distribution systems, EV's, Energy storage devices. An Electrical Technician shall apply the knowledge of Power electronics to control and convert Electrical Power for an application.

2. Course Outcomes/Skill Sets: On successful completion of the course, the students will be able to

CO-01	Identify the power electronic devices using relevant datasheets and demonstrate its suitability to produce specified electrical and thermal characteristics.
CO-02	Build a power electronic circuit for a given application, demonstrate its working either in real or simulated environment.
CO-03	Test a given power electronic circuit, identify the problem and troubleshoot to obtain the desired result/output.

3. Course Content

Week	**CO**	**PO***	**Lecture (Knowledge Criteria)**	**Tutorial (Activity Criteria)**	**Practice (Performance Criteria)**
			3 hours/week	1 hour / week	4 hours/week (2 hours/batch twice in a week)
1	1,2	1,4	1. Concept of power electronics, Draw the layer structure of the power diode and explain it. V –I characteristics of power diode.	Refer Table 1	1a. Study and interpret the datasheet of given power diode and BJT. 1b. Test the given Diode and BJT for its working condition. 1c. Simulate VI characteristics of power diode.
			2. Types of power diodes and their applications		2. Simulate output characteristics of Power BJT
			3. Types of Power transistors, BJT output characteristics, BJT as a switch.		
2	1,2	1,4	1. Operation of N-channel enhancement power MOSFET, and its transfer characteristic curve, Application of MOSFET.	Refer Table 1	1a. Study and interpret the datasheet of power MOSFET and IGBT 1b. Identify various Power MOSFET by its number and test by using a multimeter 1c. Identify IGBTs by their numbers and test by using a multimeter.
			2. Structure of IGBT and its characteristics		

			3. Application of IGBT, Compare MOSFET, BJT and IGBT		2a. Simulate the transfer characteristics of power MOSFET and IGBT. 2b. Rig up the circuit of power MOSFET as a switch
3	1,2	1,4	1.Layer diagram of SCR and Concept of two transistor analogy of SCR. 2. Static V-I characteristic curve of SCR, Enumerate Reverse blocking, Forward blocking, forward conduction mode. 3. GTO, principle of operation and list its application, layer structure of LASCR and explain its operation.	Refer Table 1	1.Test the given SCR for its working condition. 2. Simulate VI characteristics of SCR, GTO and LASCR.
4	1,2	1,4	1. Layer structure, operation and characteristics of TRIAC 2. 4-Modes of turn on of TRIAC and state the preferred mode of turn-on. 3. Operation of DIAC and its V-I characteristic, curve, application of DIAC.	Refer Table 1	1a. Test the given TRIAC and DIAC for its working condition. 1b. Simulate VI characteristics of TRIAC and DIAC. 2.Build and test a TRIAC- fan motor speed control circuit.
5	1,2	3,4	1. **SCR Control Circuits:** Methods of turn on of SCR 2. General layout of firing circuit. 3. R firing circuit and R-C firing circuit with waveforms.	Refer Table 1	1.Build R firing circuit and determine the maximum firing angle. 2. Build R – C firing circuit and determine the maximum firing angle.
6	1,2	3,4	1. Construction, operation and characteristics of UJT 2. Synchronized UJT pulse trigger circuit with waveform. 3. Digital firing scheme with waveforms.	Refer Table 1	1.Build and test UJT Relaxation oscillator. 2. Build and Test time delay relay using SCR and UJT.
7	1,2	3,4	1. Commutation, line commutation, forced commutation and methods of forced commutation, Load commutation and complementary commutation. 2. Voltage and current ratings of SCR and Reliability of SCR, MTBF. 3. How SCR can be protected against overvoltage and over current, di/dt & dv/dt. Different types of mounting of SCR.	Refer Table 1	1.Simulate Line commutation and forced commutation circuits and observe waveforms. 2. Construct a snubber circuit for protecting SCR use freewheeling diode to reduce back emf.
8	1,2	4	1. **CONVERTERS:** types of power electronic converters: Single -quadrant semi-converter, two- quadrant full- converter and dual converter. 2. Single-phase full converter RLE type with continuous load current	Refer Table 1	1.Build single-phase full controlled bridge converter for resistive load. Trace the waveforms across SCR and load. 2. Simulate single-phase Dual

			3.single-phase dual converter and principle of operation.		converter and observe waveforms.
9	1,2	4	1. Gating pulse requirement of three-phase full converters. 2.Three-phase bridge converter and 180 conduction mode with waveforms.	Refer Table 1	1.Test three-phase bridge rectifier module (36MT160) 2. Simulate three-phase Bridge converter and observe waveforms.
10	1,2	4	1. DC Chopper- Step-down and Step-up chopper and its operation. 2. Different chopper configurations- (A, B, C, D and E). 3. Inverter- Types of inverters (VSI and CSI).	Refer Table 1	1.Simulate/Build step-down chopper and observe waveforms. 2. Simulate / Build step-up chopper and observe waveforms.
11	1,2	4	1. Half bridge and full-bridge inverter and its operation. 2. Cycloconverter- Draw the circuit of mid- point Step-down cyclo-converter and its operation with waveforms. 3. Cycloconverter- Draw the circuit of a mid- point step-up cycloconverter and its operation with waveforms.	Refer Table 1	1.Simulate Full-bridge Inverter and observe waveforms. 2.Build and test a inverter. **Ref.7(18)**
12	2,3	2,4	**DC-DC converters:** 1. Working principle of Buck converter (regulator). 2. Working principle of Boost converter (regulator). **Ref.7(9,10,11,12)** 3.Working principle of Buck-boost and flyback converter. **Ref.7(14,15,16,17)**		1a. Build & test IC based - DC –DC converter for different voltages. **Ref.7(8)** 1b. Test the monolithic synchronous buck regulator (MP2305). 2.Test and Troubleshoot regulators. **Ref.7(13)**
13	2,3	2,3,4	1. SMPS and its operation and application. 2. UPS, Battery size and required voltage for UPS 3a. Draw the block diagram of offline online UPS and its operation. 3b. List basic troubleshooting steps for UPS. **Ref.7(21,23)**		1a. Identify various input and output sockets/ connectors of the given SMPS. 1b. Identify major sections/ ICs/components of SMPS. 1c. Troubleshoot given SMPS. **Ref.7(19,20)** 2a. Identify front panel control & indicators of UPS. 2b. Connect battery & load to UPS & test on battery mode. 2c. Open top cover of UPS & identify isolator transformer & UPS transformer & additional circuit other than inverter.

					2d. Identify various circuit boards in UPS and monitor voltages at various test points. 2e. Test UPS under fault condition & rectify fault. **Ref**: **7(22,24)**
Total in hours			**39**	**13**	**52**

***PO= Program Outcome as listed and defined in year 1 curriculum and CO-PO mapping with strength (Low/Medium/High) has to be mapped by the course coordinator. (Above only suggestive).**

Table 1: Suggestive Activities for Tutorials: (The List is only shared as an Example and not inclusive of all possible activities of the course. Students and Faculty are encouraged to choose activities that are relevant to the topic and on the availability of such resources at their institution).

Sl No	week	Activity
1	1	Study a datasheet of power diode 6A01-6A0, select a diode which has peak repetitive voltage (VRRM) of 1000V, RMS Voltage of 700V, Average rectified current of 6 Amp, can withstand temperature of 150 degrees Celsius. Demonstrate in the class importance of the Datasheet in selecting a diode for given electrical and thermal characteristics. Demonstrate method of mounting of a given power diode or its alternative.
2	2	Study Data sheet of given IGBT (FGA15N120 IGBT) 1. Explain Pin description of IGBT 2. List Explain the features of given IGBT 3. List alternatives for given IGBT 4. List applications of IGBT 5. Rig up a circuit to turn on/ off IGBT 6. Explain switching characteristics of given IGBT
3	3	Study Data sheet of given SCR (TN3050H-12WY) 1. Explain features of given SCR 2. Explain Pin description of given SCR 3. Analyse electrical characteristics of SCR, check suitability of SCR for a given specification.
4	4	Study Data sheet of given TRIAC (BTA16-600CW3G) 1. Explain features of given TRIAC 2. Explain Pin description of given TRIAC 3. Analyse electrical characteristics of TRIAC, check suitability of TRIAC for a given specifications.
5	5	Design an R-triggering circuit for a half wave-controlled rectifier circuit for 24 V ac supply. The SCR to be used has the following data. Igmin = 0.1 mA, Igmax = 12 mA, Vgmin = 0.6V, Vgmax = 1.5 V
6	6	Design a UJT relaxation oscillator using UJT2646 for triggering an SCR. The UJT has the following parameters η = 0.63, VBB = 20 V, VP = 13.2 V, IP = 50 μA VV = 2 V, IV = 6 mA, RBB = 7 kΩ, leakage current = 2.5 mA Also find the minimum and maximum time period of oscillation.
7	7	Design snubber circuit to protect given SCR against dv/dt used in single-phase converter circuits. Input line to line voltage has peak value of 425 volts and source inductance is 0.2 H

8	8	1.Explain advantages and disadvantages of power electronic converters. 2. Study Industrial rectifiers 1) List Types of Industrial rectifiers and their applications 2) Typical specifications of commercially available rectifiers 3) Cooling methods employed in rectifiers.
9	9	Study given Standard Rectifier Module (VUO190-16NO7) 1. List the features of given Rectifier module **2.** List applications of given Rectifier module 3. Explain the different ratings of the Rectifier module. 4. Check its suitability for a given specification Study Industrial rectifiers 1) List Types of Industrial rectifiers and their applications 2) Typical specifications of commercially available rectifiers 3) Cooling methods employed in rectifiers
10	10	Study the Intelligent Power Module (STK551U3A2A-E) 1. Explain features of Intelligent power module 2. List applications of Intelligent power module 3. Explain rating of given IPM
11	11	Study research report "DC-DC Converter Topologies for Electric Vehicles, Plug-in Hybrid Electric Vehicles and Fast Charging Stations: State of the Art and Future Trends" 1. Explain Block diagram of an electric vehicle powertrain. 2. Compare batteries, supercapacitors and fuel cells. 3. Explain Categories of DC-DC Converter for EVs' Powertrain 4. Parameter comparison of Si with respect to Wide Bandgap Semiconductors (SiC and GaN.) 5. Explain Why WBGs (SiC and GaN.) are preferred in EVs
12	12	Study the latest technological changes in this course and present the impact of these changes on industry.
13	13	Study the latest technological changes in this course and present the impact of these changes on industry.

4. CIE and SEE Assessment Methodologies

Sl. No	**Assessment**	**Test Week**	**Duration** In minutes	**Max marks**	**Conversion**
1.	CIE-1 Written Test	5	80	30	Average of three tests 30
2.	CIE-2 Written Test	9	80	30	
3	CIE-3 Written Test	13	80	30	
4.	CIE-4 Skill Test-Practice	6	180	100	Average of two skill test reduced to 20
5	CIE-5 Skill Test-Practice	12	180	100	
6	CIE-6 Portfolio continuous evaluation of Tutorial sessions through Rubrics	1-13		10	10
Total CIE Marks					60
Semester End Examination (Practice)			180	100	40
Total Marks					**100**

5. Format for CIE written Test

Course Name	**Power Electronics**	Test	I/II/III	Sem	III/IV
Course Code	**20EE42P**	Duration	80 Min	Marks	30

Note: Answer any one full question from each section. Each full question carries 10 marks.

Section	Assessment Questions	Cognitive Levels	Course Outcome	Marks
I	1			
	2			
II	3			
	4			
III	5			
	6			

Note for the Course coordinator: Each question may have one, two or three subdivisions. Optional questions in each section carry the same weightage of marks, Cognitive level and course outcomes.

6. Rubrics for Assessment of Activity (Qualitative Assessment)

Sl. No.	**Dimension**	**Beginner**	**Intermediate**	**Good**	**Advanced**	**Expert**	**Students Score**
		2	4	6	8	10	
1		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	8
2		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	6
3		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2
4		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2
	Average Marks= (8+6+2+2)/4=4.5						**5**

Note: Dimension and Descriptor shall be defined by the respective course coordinator as per the activities

7. Reference:

Sl. No	**Description**
1	Power Electronics by Dr P S Bimbhra , Khanna Publishers, New Delhi
2	Industrial Electronics and Control Biswanath Paul PHI Publication Edition-II
3	Thyristorised power controllers GK Dubey
4	Power and industrial Electronics by Harish C Rai
5	Power electronics by Mohan Undeland & Robbins, Wiley Publications
6	Modern Power Electronics by P.C.Sen
7	Power Electronics – RaghunathRao
8	https://components101.com/ics/ncp3064-dc-dc-converter-ic
9	https://www.youtube.com/watch?v=4IQBN6Oy8Lg
10	https://www.youtube.com/watch?v=_Rf29oUGpwI
11	https://www.youtube.com/watch?v=vmNpsofY4-U
12	https://www.youtube.com/watch?v=yD7fMylYgXw
13	https://www.youtube.com/watch?v=-3tBw6WSZVM
14	https://www.youtube.com/watch?v=zNfbbPobtus
15	https://www.youtube.com/watch?v=ZiD_X-uo_TQ
16	https://www.youtube.com/watch?v=9--_jaxiXhE
17	https://www.youtube.com/watch?v=Fk-B6OO6GB8https

18	https://www.youtube.com/watch?v=6CsTIPjFZ48 www.youtube.com/watch?v=I8c5DLJgS3o
19	https://www.youtube.com/watch?v=PPLjXkca7eo
20	https://www.powersupplyrepairguide.com/previewsmpsebook.pdf
21	https://www.youtube.com/watch?v=C1BYo88HSU0
22	https://www.youtube.com/watch?v=3oq18dZmb3Q
23	https://www.apc.com/lr/en/faqs/FA279110/
24	https://www.youtube.com/watch?v=lkriUIUdflM https://www.youtube.com/watch?v=JHgKBDoQCyQ
25	https://inst.eecs.berkeley.edu/~ee100/su07/handouts/EE100-MultiSim-Tutorial.pdf
26	http://eceweb1.rutgers.edu/~psannuti/ece223/Manual-for-multisim.pdf
27	https://www.multisim.com/help/getting-started/

8.1 CIE-4&5 Skill Test Scheme of Evaluation

SL. No.	Particulars/Dimension	CO	Marks
1	Portfolio evaluation of Practice Sessions		10
2	Identify and explain the Data Sheets for the given power Electronic Devices	1	10
3	Demonstrate the working condition of power electronics devices (power Diode, power transistors).	2	10
4	Identify the problem in a given circuit and demonstrate the troubleshooting method used to rectify that problem.	3	20
5	Building and Demonstration of the working Circuit including i.Drawing of the Circuit diagram using the right symbols 05 ii. Build the circuit as per the circuit diagram 10 iii. Demonstrate the working of the circuit. 20 iv. Document the necessary readings of the expected circuit outcomes. 05	2	40
6	Viva-voce		10
	Total Marks		**100**

8.2 SEE Scheme of Evaluation

SL. No.	Particulars/Dimension	CO	Marks
1	Portfolio evaluation of Practice Sessions		10
2	Building and Demonstration of the working Circuit including i.Drawing of the Circuit diagram using the right symbols 10 ii.Identify and explain the Data Sheets for the given power Electronic Devices.10 iii. Demonstrate the working condition of power electronics devices. 10 iv. Build the circuit as per the circuit diagram 15 v. Demonstrate the working of the circuit. 20 iv. Document the necessary readings of the expected circuit outcomes. 05	2	70
3	Viva-voce		20
	Total Marks		**100**

9. Equipment/software list with Specification for a batch of 20 students

Sl. No.	Particulars	Specification	Quantity
1	DC Regulated power supply	(0-300V, 2A)	5
2	DC Regulated Dual power supply	(0-30V,2A)	5
3	Cathode Ray Oscilloscope	Dual trace, 25 MHz.	5
4	Digital Multimeter	31 /2"1-ph	5

5	1-ph Induction Motor	220v,1ph,	1
6	Battery	6 V/12 V 60 AH	2
7	SMPS		5
8	UPS 2kVA	2 kVA	1
Software			
1	GNU-Octave/MatLab/P-spice/Multisim		20 License

Government of Karnataka
DEPARTMENT OF COLLEGIATE AND TECHNICAL EDUCATION

Programme	Electrical and Electronics Engineering	**Semester**	IV
Course Code	20EE43P	**Type of Course**	Programme Core
Course Name	Fundamentals of Automation Technology	**Contact Hours**	8 hours/week 104 hours/semester
Teaching Scheme	L:T:P :: 3:1:4	**Credits**	6
CIE Marks	60	**SEE Marks**	40

1.Rationale:
The aim of this course is to introduce students to the present Industrial Automation scenario in India. The broad knowledge of essential component of present industrial Automation Industry such as Programmable Logic Controller (PLC), Distributed Control System (DCS), Supervisory Control and Data Acquisition (SCADA), industrial drives, human machine interface will enable the students to maintain the above automation controls systems used in the present industry. Thus this course is very important for students who want to use their knowledge of electronic engineering for working in the industrial automation sector.

2. Course Outcomes/Skill Sets: On successful completion of the course, the students will be able to

CO-01	Select a suitable sensor and actuator for a given automation application and demonstrate its use in a specific application.
CO-02	Install, test & control the pneumatic actuators using various pneumatic valves.
CO-03	Develop ladder diagrams for a given application and explain its implementation process using PLC.
CO-04	Describe the concept of SCADA and DCS systems and list their various applications.

3. Course Content

Week	**CO**	**PO***	**Lecture (Knowledge Criteria)**	**Tutorial (Activity Criteria)**	**Practice (Performance Criteria)**
			3 hours/week	1 hour/ week	4 hours/week (2 hours/batch twice in a week)
1	1	2,3, 4	1. How do engineers work, technical drawings and parts lists, Circuit diagrams, Flow charts and programs. **Ref.7(1)** 2. Technical plans and schematic diagrams, Calculations and simulation 3. Automation technology as a part of engineering sciences, Key development milestones in the history of automation technology, Effects of automation on people.	Refer Table 1	Video demonstration on Automation technology
2	1	1,4	1. How a solenoid works- Structure of a solenoid, Applications of solenoids **Ref.7(1)** 2. Solenoids as simple actuators. 3.How switches work and their structure-Normally open contacts, normally closed contacts, Changeover switches.	Refer Table 1	1.Test a Linear Actuator Solenoid 2.Install, wire and test digital time delay relay -

			Relays and contactors-Structure of a relay, Applications of relays, Time relays. **Ref.7(1)**		
3	1	1,4	**1.Sensors: operation, characteristics and application:** Inductive Proximity Sensors, Magnetic Proximity Sensor. 2. Capacitive proximity sensors, Optical proximity sensors, Ultrasonic proximity sensors 3. Linear Position sensors, Photoelectric sensors. Infrared sensors Limit Switches.	Refer Table 1	1a. Identify and test different sensors. 1b. Select a suitable proximity sensor for a given application and wire up the same. **Ref 7(2)** 2.Develop a relay-based motor control automation such that the motor reverses its direction when the limit switches are activated.
4	1	4	1. Inductive linear transducer, area sensors, flow sensors **Ref.7(1)** 2. Temperature sensors, colour sensors, Hall effect sensor 3a. Pressure sensors -Electronic pressure switches with binary output signal. 3b. Concept of Sensor latching. Latching Digital Hall effect sensor.		1.Identify and test different sensors. 2. Simple Hall effect sensor Latching ON/OFF Relay switch Circuit.
5	2	1,4	1. **Fundamentals of pneumatics-** Individual components in a pneumatic control system and their functions. **Ref.7(1)** 2. Functions and features of actuators (pneumatic cylinders)- Single-acting cylinder, Double-acting cylinders, Speed regulation with single-acting cylinders, Speed regulation with double-acting cylinders. 3. Functions and features of pneumatic valves- Pneumatic valve designations and symbols, Pneumatic valve actuation types, controlling a single-acting cylinder, Controlling a double-acting cylinder	Refer Table 1	1a. Controlling of single-acting cylinder by 3/2 push-button valve/ **solenoid valve** b. Controlling of double-acting cylinder by 5/2 push-button valve/S**olenoid valve** c. Identify industrial applications of Single acting and Double acting cylinder. **Ref 7(3,4)** 2 a. Speed control of single-acting cylinders by flow control valve b. Speed control of double-acting cylinders by flow control valve
6	2	1,4	1. Functions and features of pneumatic drives- Guided cylinders, rodless linear drives and rotary drives. **Ref.7(1)** 2. Pneumatic grippers.	Refer Table 1	1. Demonstrate the use of Pneumatic drives (used in small robots) 2. Demonstrate the use of Pneumatic grippers.

			3. Pneumatic control system represented in a circuit diagram- Symbol designations in circuit diagrams.		
7	1	1,4	1. **Electric drives:** Physical/technical fundamentals of the DC motor. 2. Activating DC motors 3. Working principle of Variable frequency drive.	Refer Table 1	1. Activate the DC motor using 2 relays to run the motor forward and backward direction. 2. Install and control speed of 3-ph motor using VFD.
8	3	1,4	1. **Fundamentals of control technology**: Meaning of control system, open loop and closed system with examples. Different types of controllers (PLC, CNC, Hard-wired programmed control systems, robot controllers) 2. How programmable logic controllers (PLCs) work and their structure. Advantages and Disadvantages of PLC. Mathematical fundamentals – basic logic functions-Identity (YES function), Negation (NOT function), Conjunction (AND function), Disjunction (OR function), XNOR and XOR. 3. Examples of controller structure.	Refer Table 1	1.Demonstrate open loop and closed systems observed in everyday life. 2. Demonstrate Industrial applications of PLC
9	3	1,4	1. **Programmable logic controllers-** Internal architecture and functional structure. Input/output modules. 2a. List input / output devices of PLC. -List types of PLC. 2b. Functions of Programming equipment (Programmer/monitor) 3a. Explain PLC Programming Languages –Ladder diagram/ Functional Block Diagram /Instruction List/structured text. 3b. Explain scope of f IEC standard for PLC: IEC 61131	Refer Table 1	1.a. Identify Components of PLC b. Identify different types of PLC c. Identify different input and output devices of PLC d. Identify the wiring mode of PLC- sourcing and sinking modes 2.Identify and Install Programming Software and communication driver.
10	3	2,3, 4	1a. **Operation cycle of PLC**: Input scan, Program scan and Output scan. **1b. Operation modes of PLC**: program, run and test modes. Data files and program files. 2.Configuration of I/Os and Addressing I/Os, study of PLC symbols.		1.Develop and test the ladder programs for the following motor controls: a) Starting from two different locations (OR Function) b) Stopping from one position (NOT Function)

			3. Procedure for drawing ladder diagram, connection of inputs and outputs to input and output module and entering ladder program into PLC (CPU). Draw the ladder diagram for a simple example of one-contact, one-coil circuit and connection diagram showing how inputs are connected to the input and output module of PLC.		c) Two hand operation (AND Function) d) Stopping from two different locations (NOT+OR or NOR Functions) e) Stopping if both signals are given (NOT+AND or NAND functions) f) Memory function (Signal is maintained or holding) g) Interlocking protection (XNOR/XOR)
					2. Develop and test the ladder program for interlocking two motors, using **PLC simulation software.**
11	3	2,3, 4	1.Most commonly used PLC programming instructions and their applications: XIC, XIO, OTE. Latch, Unlatch		1a. Develop and test ladder program for switching ON motor 1, motor 2 and motor 3 in sequence with some time delay, using **PLC simulation software.** 1b. Develop and test the ladder program of the Alarm system for the following conditions: If one input is ON- nothing happens, if any two inputs are ON- a red light turns ON, If any three inputs are ON- a Hooter/Alarm turns ON, using PLC simulation software.
			2.Describe Timer instructions and their application: Describe Timer On Delay (TON), Timer Off Delay (TOF), Retentive Timer On (RTO)		
			3.Describe counter instructions and their application: COUNT UP, COUNTDOWN, UP/DOWN COUNTER Examples of use of counter and timer instructions.		2a. Develop and test ladder Program for fully Automatic Star-Delta starter, using **PLC simulation software.** 2b. Develop and test ladder Program to control automatic washing machine, using **PLC simulation software.**
12	3	2,3, 4	Wiring sensors to PLC 1.Wiring push button to PLC, and selector switch to PLC		1.Develop and run simple Ladder programs to read sensor status and to control various output. **LED is turned ON when a (proximity sensor) sensor is activated.** i. Draw the ladder diagram ii. Draw PLC wiring diagram. iii. Wire push buttons to input module and LED to output module. iv. Enter the ladder program into the PLC simulator and execute.

					v. If the program is error free, Upload the program into PLC and execute. vi . observe the output
			2.Wiring NPN sensor to PLC		2. Double acting cylinder is used to perform machining operations. Pneumatic cylinder is advanced by pressing two push buttons simultaneously. If any one of the push button is released, cylinder comes back to start position. Draw the pneumatic circuit, PLC wiring diagram and ladder diagram to implement this task.
			3.Wiring PNP sensor to PLC		
13	4	2,3, 4	1.Meaning of SCADA -Functions of each component of SCADA system, -Describe SCADA Hardware and software -Applications of SCADA.		Demonstrate application of SCADA/HMI/DCS
			2.Meaning of HMI and its applications. -Need & types of HMI. -Advantages of HMI. -Various software's used for Programming HMI. -Interfacing HMI and PLC- General block diagram.		
			3. Concept of DCS -Hierarchy of DCS. -Functions of each level of DCS.		
Total in hours			**39**	**13**	**52**

***PO= Program Outcome as listed and defined in year 1 curriculum and CO-PO mapping with strength (Low/Medium/High) has to be mapped by the course coordinator. (Above only suggestive).**

Table 1: Suggestive Activities for Tutorials: (**The List is only shared as an Example and not inclusive of all possible activities of the course. Student and Faculty are encouraged to choose activities that are relevant to the topic and on the availability of such resources at their institution**)

Sl No.	Week	Activity
1	1	Prepare a report on how Automation impacts our lives at present.

2	2	Study time relay 1. Explain the use of time relay in Traffic signal control with a circuit diagram 2. Explain working of circuit 3. List different types of timer relays used in circuit 4. Explain specification and feature of given INTERVAL ON delay relay 5. Explain specification and feature of given SINGLE SHOT time delay relay
3	3	I. Study LVDT 1. Explain working principle of LVDT 2. List the applications of LVDT 3. List the benefits of LVDT II. Develop an automatic door system using optical sensor and linear actuator. https://www.instructables.com/Automatic-Door-Opening-and-Closing-System-Using-IR/
4	4	Study digital Hall effect sensor (SS361RT, SS461R). 1. List features of Hall effect sensor 2. List applications Hall effect sensor 3. Explain electrical characteristics of Hall effect sensor
5	5	I. List the advantages of pneumatics and explain application of pneumatics in automation. II. Problem statement: Workpieces are transported to a processing unit on a conveyor belt. The workpieces have to be separated upstream of the processing unit. The separating cylinder's end positions are monitored using magnetic proximity switches. 1. Describe the function of a magnetic proximity switch. 2. Select a suitable proximity switch for monitoring the end position of a cylinder 3. Explain terminology from the field of proximity switch technology. 4. Determine whether or not a solenoid valve can be directly actuated by a proximity switch. 5. Describe different types of proximity switches
6	6	I. For the given application (Sorting device for metal stampings) 1.Suggest Suitable pneumatic cylinder 2. Draw circuit diagram II. For the given application (separating parcel post) 1.Suggest Suitable pneumatic cylinder 2. Draw circuit diagram III. For the given application (Quarry stone sorter) 1.Suggest Suitable pneumatic cylinder 2. Draw circuit diagram
7	**7**	Study given commercially available VFD 1. List its features 2. Applications of VFD 3. Explain specification of VFD 4. Types of VFD available in the market.
8	**8**	Study PLC based sand mixing Machine 1. Explain sequence of operation 2. Draw and explain the relay Ladder Logic diagram 3. Draw and explain the Ladder diagram
9	**9**	Study LIFT Control using PLC 1. Explain sequence of operation. 2. Draw and explain the Ladder diagram.
10	10	Study PLC Conveyor Motor Ladder Logic 1. Explain sequence of operation

		2. Draw the relay schematic 3. Draw the Ladder diagram 4. Explain the type of sensor used to detect the object
11	11	Prepare a report on Industry 4.0 and present.
12	12	Study the latest technological changes in this course and present the impact of these changes on industry.
13	13	Study the latest technological changes in this course and present the impact of these changes on industry.

4. CIE and SEE Assessment Methodologies

Sl. No	**Assessment**	**Test Week**	**Duration** In minutes	**Max marks**	**Conversion**
1.	CIE-1 Written Test	5	80	30	Average of three tests 30
2.	CIE-2 Written Test	9	80	30	
3	CIE-3 Written Test	13	80	30	
4.	CIE-4 Skill Test-Practice	6	180	100	Average of two skill test reduced to 20
5	CIE-5 Skill Test-Practice	12	180	100	
6	CIE-6 Portfolio continuous evaluation of Tutorial sessions through Rubrics	1-13		10	10
Total CIE Marks					60
Semester End Examination (Practice)			180	100	40
Total Marks					**100**

5. Format for CIE written Test

Course Name	**Fundamentals of Automation Technology**	Test	I/II/III	Sem	III/IV
Course Code	**20EE44P**	Duration	80 Min	Marks	30
Note: Answer any one full question from each section. Each full question carries 10 marks.					
Section	Assessment Questions		Cognitive Levels	Course Outcome	Marks
I	1				
	2				
II	3				
	4				
III	5				
	6				
Note for the Course coordinator: Each question may have one, two or three subdivisions. Optional questions in each section carry the same weightage of marks, Cognitive level and course outcomes.					

6. Rubrics for Assessment of Activity (Qualitative Assessment)

Sl. No.	Dimension	Beginner	Intermediate	Good	Advanced	Expert	Students Score
		2	4	6	8	10	
1		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	8
2		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	6
3		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2
4		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2
	Average Marks= (8+6+2+2)/4=4.5						**5**

Note: Dimension and Descriptor shall be defined by the respective course coordinator as per the activities

7. Reference:

Sl. No.	Description
1	https://dlb.sa.edu.au/rehsmoodle/file.php/441/Teachware/563060 Fundamentals of automation technology.pdf
2	https://www.festo-didactic.com/ov3/media/customers/1100/566920 leseprobe en 2.pdf
3	https://www.youtube.com/watch?v=ZXANgP-q6b4
4	https://www.festo-didactic.com/ov3/media/customers/1100/566910 leseprobe.pdf
5	https://www.youtube.com/watch?v=GhS1qpHoSX0
6	https://www.youtube.com/watch?v=O-hbGD HsYk
7	**Control of Machines- S.K. Bhattacharya & Brijinder Singh, New Age International Publishers**
8	**Programmable Logic Controllers: John W.Webb, Ronald A.Reis, PHI**
9	**Introduction to PLC by Gary Dunning, Cengage Learning.**
10	**Mechatronics: W.Bolton**
11	https://nptel.ac.in/content/storage2/courses/112106175/downloads/Module%204/SELF%20EVALAUTION/SE-Lecture%2041.pdf
12	https://accautomation.ca/wiring-push-buttons-and-selector-switch-to-click-plc/
13	https://realpars.com/discrete-sensors-part-1/
14	https://www.automationdirect.com/adc/overview/catalog/sensors -z- encoders
15	https://www.rtautomation.com/technologies/control-iec-61131-3/
16	https://davidrojasticsplc.files.wordpress.com/2009/01/libro-en-espanol.pdf

8.1 CIE-4 Skill Test Scheme of Evaluation

SL. No.	Particulars/Dimension	CO	Marks
1	Portfolio evaluation of Practice Sessions (week1-week6)		10
2	1. Identify different pneumatic components 2. Identify various sensors	1 & 2	10
3	Select and test suitable sensor for a given application 05+15	2	20
4	Test a given Linear Actuator Solenoid OR Install, wire and test digital time delay relay	2	15
5	Demonstrate & control the Pneumatic actuators using pneumatic valves. i. Draw the circuit diagram using right symbols 05 ii. Build the circuit as per the circuit diagram 10 iii. Demonstrate the operation of a Pneumatic actuators 20	3	35
6	Viva voce		10
	Total Marks		**100**

8.2 CIE-5 Skill Test Scheme of Evaluation

SL. No.	Particulars/Dimension	CO	Marks
1	Portfolio evaluation of Practice Sessions (week7- week12)		10
2	i. Identify different input and output devices of PLC	3	10

	ii. Identify various indicators on PLC Modules.		
3	Explain Scope of IEC standard for PLC: **IEC 61131**	3	10
4	Demonstrate the implementation of given application using PLC i. Draw the ladder diagram and PLC wiring diagram using right symbols 10 ii. Simulate the ladder diagram using PLC simulator and check the automation logic by activating the respective inputs 20 iii. Upload the Ladder program into PLC and execute 10 iv. Demonstrate desired output from PLC. 20	3	60
5	Viva voce		10
	Total Marks		**100**

8.3 SEE Scheme of Evaluation

SL. No.	Particulars/Dimension	CO	Marks
1	Portfolio evaluation of Practice Sessions		10
2	i. For a given automation application select suitable pneumatic components and sensors.	1, 2	10
3	Demonstrate & control the Pneumatic actuators using pneumatic valves. i. Draw the circuit diagram using right symbols 10 ii. Build the circuit as per the circuit diagram 20 iii. Demonstrate the operation of a Pneumatic actuators 10 **OR** Demonstrate the implementation of given application using PLC i. Draw the ladder diagram using right symbols 10 ii. Simulate the ladder diagram using PLC simulator and check the automation logic by activating the respective inputs 15 iii. Upload the Ladder program into PLC and execute 05 iv. Demonstrate desired output from PLC. 10	1 /3	40
4	Demonstrate simple application of SCADA using SCADA software.	4	20
5	Viva voce		20
	Total Marks		**100**

9. Equipment/software list with Specification for a batch of 20 students

Sl. No.	Particulars	Specification	Quantity
1	Small compressor	4 bar, 1.5 HP,0-4 bar pressure, 0-10 litres	1
2	Linear Actuator Solenoid 12V		20
3	Inductive. Proximity Sensors. Magnetic Proximity Sensor, Limit Switches		20 each
4	Capacitive proximity sensors, Optical proximity sensors Ultrasonic proximity sensors		20 each
5	Infrared sensors, Pressure Sensor and Switch		20 each
6	Inductive linear transducer , Area sensors, Flow sensors, Temperature sensors, colour sensors		20 each
7	single-acting cylinder, double-acting cylinder		10 each
8	3/2 and 5/2 push-button valve		10
9	3/2 and 5/2 solenoid valve		10
10	Flow control valves		10
11	Digital time delay relay		5
12	Direction control Valve, Double Acting Solenoid		10 each

13	Pneumatic Grippers		5
14	FRL (filter, regulator and lubricator) unit		2
15	PLC Systems with digital I/P, O/P modules and software	12/24v Dc/relay, 8 Digital Inputs, 4 Digital Outputs, ethernet card standard micro SD card, integrated webserver	10
16	Variable frequency drive	3-phase, 1HP, VFD	1
17	1 HP induction motor with DOL starter	1 HP	1
18	SCADA Software		1

Government of Karnataka
DEPARTMENT OF COLLEGIATE AND TECHNICAL EDUCATION

Programme	Electrical and Electronics Engineering	**Semester**	IV
Course Code	20EE44P	**Type of Course**	Programme Core
Course Name	Computer Aided Electrical Drafting (CAED)	**Contact Hours**	8 hours/week 104 hours/semester
Teaching Scheme	L:T:P :: 3:1:4	**Credits**	6
CIE Marks	60	**SEE Marks**	40

1.Rationale:
All equipment, installations, circuits and other electrical and electronic systems in the power and industrial sector need drawings for their manufacturing, installation, operation and maintenance. A technician working in design, shop floor and field area must possess the skill of reading, interpreting different drawings and to use Computer Aided Drawing (CAD) software to draw 2D & 3D Electrical drawings.

2. Course Outcomes/Skill Sets: *On successful completion of the course, the students will be able to*

CO-01	Study a given drawing and list all the electrical elements.
CO-02	Draw a single line diagram and control panel board wiring drawing for a given specification.
CO-03	Draw a winding and assembly drawing for a given machine and translate the assembly 2D drawing into a 3D drawing using CAD software.
CO-04	Draw a simple PLC module drawing for a given requirement using standard symbols.

3. Course Content:

Week	CO	PO*	Lecture (Knowledge Criteria)	Tutorial (Activity Criteria)	Practice (Performance Criteria)
			3 hours/week	1 hour/week	4 hours/week (2 hours/batch twice in a week)
1	1	1,4	1. INTRODUCTION to CAD commands. Practice essential commands like – line types, line weight, scale, unit, 2. Layer, block, insert, explode, purge, table, attribute, quick select 3. view, multi-view, break, join, filter, find, pan, list match properties and related commands	Tutorial hours shall be used to practice drawings.	Practice the basic CAD commands. **Ref .7(1,2,3,4,5)**
2	1,2	1,4	Single line diagram of 110 KV/11KV MUSS Single line diagram 11KV of Substation	Tutorial hours shall be used to practice drawings.	1. Single line diagram of 110 KV/11KV MUSS. **Ref .7(10,11)** 2. Single line diagram of 11KV Substation. **Ref .7(12,13,14)**
3	1,2	1,4	1. Draw and Create BOM (Bill of Material): Electrical wiring of a residential/Hospital building 2.Draw and Create BOM (Bill of Material): Electrical wiring of a small workshop	Tutorial hours shall be used to practice drawings.	1. Draw the wiring layout of residential building/Hospital and generate BOM for a given plan with AEH. **Ref .7(7,8,9)** 2. Draw a wiring layout of a small workshop with 3 lathes, 1 drilling machine, 1 welding machine, 1

					grinding machine and generate BOM (Bill of Material).
4	1,2	1,4	Motor control Panel board Wiring.	Tutorial hours shall be used to practice drawings.	Draw MCC (Motor Control Centre) Panel board Wiring and create BOM. **Ref .7(15)**
5	1,2	1,4	Design a GA LT panel wiring drawing.	Tutorial hours shall be used to practice drawings.	Design an Electrical General Assembly of LT panel wiring. **Ref .7(16)**
6	1,2	1,4	Developed Winding Diagrams of 3-ph A.C. Machines: Single Layer Double Layer	Tutorial hours shall be used to practice drawings.	1.Develop a winding diagram- A.C. windings-Single Layer **Ref.7(6)** 2.Develop a winding diagram- A.C. windings- Double Layer
7	1,2	1,4	Developed Winding diagram of 1-ph, AC Induction Motor	Tutorial hours shall be used to practice drawings.	Develop a winding diagram for a 1-ph, Induction Motor, make terminal connections for Running & Starting Winding.
8	1,3	1,4	Transformer Assembly-Three-phase	Tutorial hours shall be used to practice drawings.	Three-phase core type 200KVA 33KV/400V transformer front elevation full in section, plan in full section. **Ref .7(18)**
9	1,3	1,4	Assembly drawing- Squirrel cage Induction motor.	Tutorial hours shall be used to practice drawings.	Draw the half end view and half sectional front elevation and half sectional end view for a 3HP 400V 50HZ 3PH 1440 RPM - Squirrel cage Induction motor. **Ref .7(19)**
10	1,3	1,4	Assembly drawing- Rotor of a 15KVA Alternator	Tutorial hours shall be used to practice drawings.	Draw the half sectional end view top half in section and half sectional front elevation for a Rotor of a 15KVA Alternator for a given sketch. **Ref .7(20)**
11	1,3	1,4	Assembly drawing – 4 Pole 25 KVA synchronous motor	Tutorial hours shall be used to practice drawings.	Draw half size half sectional elevation and half sectional end view. **Ref .7(21,22)**
12	3	1,4	3D Drawing- Squirrel cage Induction motor.	Tutorial hours shall be used to practice drawings.	3D view showing different parts. **Ref .7(23)**
13	1,4	1,4	PLC Module	Tutorial hours shall be used to practice drawings.	Design a Simple PLC Module showing I/O points. **Ref .7(24,25)**
Total in hours			**39**	**13**	**52**

***PO= Program Outcome as listed and defined in year 1 curriculum and CO-PO mapping with strength (Low/Medium/High) has to be mapped by the course coordinator. (Above only suggestive).**

4. CIE and SEE Assessment Methodologies

Sl. No	Assessment	Test Week	Duration In minutes	Max marks	Conversion
1.	CIE-1 Written Test	5	80	30	Average of three tests 30
2.	CIE-2 Written Test	9	80	30	
3	CIE-3 Written Test	13	80	30	
4.	CIE-4 Skill Test-Practice	6	180	100	Average of two skill test reduced to 20
5	CIE-5 Skill Test-Practice	12	180	100	
6	CIE-6 Portfolio continuous evaluation of Tutorial sessions through Rubrics	1-13		10	10
Total CIE Marks					60
Semester End Examination (Practice)			180	100	40
Total Marks					**100**

5. Format for CIE written Test

Course Name	**Computer Aided Electrical Drafting (CAED)**	Test	I/II/III	Sem	III/IV
Course Code	**20EE43P**	Duration	80 Min	Marks	30

Note: Answer any one full question from each section. Each full question carries 10 marks.

Section	Assessment Questions	Cognitive Levels	Course Outcome	Marks
I	1			
	2			
II	3			
	4			
III	5			
	6			

Note for the Course coordinator: Each question may have one, two or three subdivisions. Optional questions in each section carry the same weightage of marks, Cognitive level and course outcomes.

6. Rubrics for Assessment of Activity (Qualitative Assessment)

Sl. No.	Dimension	Beginner	Intermediate	Good	Advanced	Expert	Students Score
		2	4	6	8	10	
1		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	8
2		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	6
3		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2
4		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2
	Average Marks= (8+6+2+2)/4=4.5						**5**

Note: Dimension and Descriptor shall be defined by the respective course coordinator as per the activities

7. Reference:

Sl. No.	Description
1	Computer Aided Electrical Drawing - YOGESH, NAGARAJA,NANDAN PHI Publication
2	Electrical Drafting - S.F. DEVALAPUR

3	https://www.youtube.com/watch?v=pvKVy-eMDYc
4	https://www.youtube.com/watch?v=2ni0AWbloQA
5	https://www.youtube.com/watch?v=wIN61lmZByw
6	https://www.youtube.com/watch?v=OONCU5QbDpU
7	https://www.youtube.com/watch?v=asVQ3ncmqhY
8	https://www.youtube.com/watch?v=X1MsYDEkHpU
9	https://www.youtube.com/watch?v=8DEap6exAB0
10	https://www.youtube.com/watch?v=YXLhvA7dMb4
11	https://www.youtube.com/watch?v=ZRXlWoT-FRU
12	https://www.youtube.com/watch?v=Bk8YOLr0KFM
13	https://www.youtube.com/watch?v=Fa5gYiapD1E
14	https://www.youtube.com/watch?v=cKKvLXaV1g8
15	https://www.google.com/imgres?imgurl=https://5.imimg.com/data5/GZ/CR/MG/SELLER-40839587/capture7-500x500.PNG&imgrefurl=https://www.indiamart.com/proddetail/electrical-ga-general-assembly-design-22445785697.html&docid=t83B_C9sNcBtnM&tbnid=nqa2KujeGdTYhM&vet=1&w=500&h=339&hl=en-US&source=sh/x/im#imgrc=nqa2KujeGdTYhM&imgdii=pQlfLt4RiUOsdM
16	https://www.google.com/imgres?imgurl=https://5.imimg.com/data5/GZ/CR/MG/SELLER-40839587/capture7-500x500.PNG&imgrefurl=https://www.indiamart.com/proddetail/electrical-ga-general-assembly-design-22445785697.html&docid=t83B_C9sNcBtnM&tbnid=nqa2KujeGdTYhM&vet=1&w=500&h=339&hl=en-US&source=sh/x/im
17	https://www.youtube.com/watch?v=XsKbtm6OtAw
18	https://www.youtube.com/watch?v=fXOwgNYT0hg
19	https://www.youtube.com/results?search_query=Squirrel+cage+Induction+motor++assembly+cad+drawing
20	https://www.youtube.com/watch?v=nk_hmXUtiPk
21	https://www.youtube.com/watch?v=nk_hmXUtiPk
22	https://www.youtube.com/watch?v=rgP0aMth7LM
23	https://www.youtube.com/watch?v=fAN9jxydoMA&t=144s
24	https://www.youtube.com/watch?v=fTjd86ui5iM
25	https://www.youtube.com/watch?v=_0b2YDYFgZA
26	https://bescom.karnataka.gov.in/page/Departments+of+Corporate+Office/Quality%20Standards%20and%20Safety/Drawings/en
27	https://www.electricaltechnology.org/2012/02/star-delta-3-phase-motor-starting.html

8.1. CIE-1 Skill Test Scheme of Evaluation

SL. No.	Particulars/Dimension		Marks
1	Draw the single line diagram of a MUSS/substation i. Use of suitable commands ii. Labelling iii. Indexing	25 15 10	50
2	Draw the wiring diagram of a MCC Panel Board i. Use of suitable commands ii. Labelling iii. Indexing	25 15 10	50
		Total Marks	**100**

8.2: CIE-2 Skill Test Scheme of Evaluation

SL. No.	Particulars/Dimension	Marks
1	Design a Simple PLC Module showing I/O points. i. Use of suitable commands 20 ii. Labelling 10 iii. Indexing 10	40
2	Assembly drawings Sectional end view and front elevation (Front elevation and plan in case of transformer) i. Use of suitable commands 10 ii. Sectional end view/ front elevation 15 iii. Front elevation/plan 10 iv. Dimensioning 10 v. Labelling 05	50
3	Translate 3D drawing for the given Sketch (CAD)	10
	Total Marks	**100**

8.3: SEE Scheme of Evaluation

SL. No.	Particulars/Dimension	CO	Marks
1	**Winding diagrams** Draw the winding diagram using CAED software. 20 i. Develop winding table 05 ii. Draw sequence diagram 05 iii. Mark the poles 05 iv. Show the direction of induced emf and indicate the position of brushes and show the direction of current. 05 **OR** **Single line diagram** Draw the single line diagram of a MUSS/substation i. Use of suitable commands 20 ii. Labelling 10 iii. Indexing 10 **OR** **Building wiring drawing/Panel Wiring Drawing** Estimate and draw Electrical wiring of a residential building/ Estimate and draw: Electrical wiring of a small workshop. i. Use of suitable commands 20 ii. Labelling 10 iii. Indexing 10	**1,2**	40
2	**Assembly drawings** Sectional end view and front elevation (Front elevation and plan in case of transformer) i. Use of suitable commands 05 ii. Sectional end view/ front elevation 10 iii. Front elevation/plan 10 iv. Dimensioning 10 v. Labelling 05 **OR** 3D Drawing- Squirrel cage Induction motor. i. Use of suitable commands 25 ii. Labelling 15 iii. Indexing 10	**1,3, 4**	50
3	Viva-voce		10
	Total Marks		**100**

9. Equipment/software list with Specification for a batch of 20 students

Sl. No.	Particulars	Specification	Quantity
1	**Personal Computer**	● Operating **System**: 64-bit Microsoft Windows 10. ● Processor: 2.5 GHz (3+ GHz recommended) ● Memory: 8 GB (16GB recommended) ● Disk space: 1TB. ● Display: 1920 x 1080 resolution with True Color.	**20**
2	**Electrical Computer Aided Drafting Software/ AutoCAD Electrical 2021**	**Student edition**	**20**

Government of Karnataka
Department of Collegiate and Technical Education

Programme	Audit Course	**Semester**	IV
Course Code	20EE45T	**Type of Course**	Audit
Course Name	**Indian Constitution**	**Contact Hours**	2 hours/week 26 hours/semester
Teaching Scheme	L:T:P :: 2:0:0	**Credits**	2
CIE Marks	50	**SEE Marks**	Nil

1. Course Outcomes: At the end of the Course, the student will be able to:

CO-01	**CO1**	Understand Preamble, salient features and importance of Indian Constitution.
CO-02	**CO2**	Understand Fundamental rights, duties and Directive principles of state policy.
CO-03	**CO3**	Understand Parliamentary system of governance, Structure, Functions, Power of Central, state governments (Legislative, Executive) and Judiciary.
CO-04	**CO4**	Understand Panchayat Raj Institutions and Local self-governments, UPSC, KPSC, NHRC, Status of women, RTE etc.

2. Course Content

Week	CO	Detailed Course Content	Contact Hours
1	1	Introduction to constitution of India-Formation and Composition of the Constituent Assembly-Salient features of the Constitution-Preamble to the Indian Constitution	2
2	1,2	Fundamental Rights- Definition, The right to equality, The right to freedom, The right against exploitation, The right to freedom of religion.	2
3	1,2	Cultural and educational rights and The right to constitutional remedies. Fundamental Duties, Directive principles of state policy.	2
4	1,3	Parliamentary system of governance- Structure of Parliament- Lok Sabha and Rajya Sabha. Functions of parliament- Legislative, Executive, Financial Function Powers of Lok Sabha and Rajya Sabha.	2
5	1,3	Procedure followed in parliament in making law, Annual financial statement (Budget) – procedure in parliament with respect to estimates, Appropriation bill, Supplementary, additional grants, Vote on account, votes on credit and exception grant, special provisions, rules of procedure.	2
6	1,3	Structure of union executive, Power and position of President. Vice President, Prime minister and council of ministers.	2
7	1,3	Structure of the judiciary: Jurisdiction and functions of Supreme Court, high court, and subordinate courts.	2
8	1,3	Federalism in the Indian constitution- Division of Powers: Union list, State list and concurrent list. Structure of state legislation, Legislative assembly and Legislative council.	2
9	1,3	Functions of state legislature, Structure of state executive-Powers and positions of Governor, Speaker, Deputy Speaker, Chief Minister and council of minister.	2
10	4	Local self-government- meaning-Three tier system, Village Panchayat-Taluk panchayat Zilla panchayat, Local bodies-Municipalities and Corporations, Bruhath Mahanagara Palike, Functions of Election commission, UPSC, KPSC.	2

11	4	Amendment of the constitution, Human Rights-Definition-constitutional provisions-right to life and liberty-Human Rights of Women-Discrimination against women steps that are to be taken to eliminate discrimination against women in Education, employment, health care, Economic and social life,	2
12	4	Status of Women in India - Women in rural areas, Constitutional Safeguards - Dowry Prohibition act 1961- Domestic violence act 2005- Sexual harassment at work place bill 2006. Human Rights of Children- Who is a child- list the Rights of the Child- Right to education, Protection of Children from Sexual Offences Act (POCSO)-2012-	2
13	1,4	National Human Rights Commission Constitution- Powers and function of the Commission-Employee rights- Provisions made, Contractual-Non contractual employee rights-Whistle blowing-definition-Aspects-Intellectual Property Rights (IPR)–Meaning-Need for protection- Briefly description of concept of patents, Copy right, Trademark	2
Total in Hours			**26 Hrs**

REFERENCES

1. Introduction to the Constitution of India- Dr. Durga Das Basu
2. Empowerment of rural women in India-Hemalatha H.M and Rameshwari Varma, Hema Prakashana.

4. CIE and SEE Assessment Methodologies

Sl. No	**Assessment**	**Test Week**	**Duration** In minutes	**Max marks**	**Conversion**
1.	CIE-1 Written Test	5	80	30	Average of three tests 30
2.	CIE-2 Written Test	9	80	30	
3	CIE-3 Written Test	13	80	30	
4.	CIE-4 MCQ	6	60	20	Average of two CIE = 20
5	CIE-5 Open Book Test	12	60	20	
Total CIE Marks					50
Semester End Examination (Practice)			-	-	-
Total Marks					**50**