

4th SEMESTER



**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 Catego ry / Teachi ng Depart ment	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																		
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	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	<p>1. Induction Motors: Working principle of induction motor. Rotating magnetic field produced by polyphase supply.</p> <p>2. Construction of stator, squirrel cage rotor and phase wound rotor. Slip, frequency of rotor current. Problems.</p> <p>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.</p>	Refer Table1	<p>Follow Safety rules and Safe working practices</p> <p>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.</p> <p>1b. Connect forward & reverse a 3-phase squirrel cage induction motor.</p> <p>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.</p> <p>Ref.7(5)</p> <p>2b. Connect forward & reverse a 3-phase slip ring induction motor.</p>
3	1	1,4	<p>1. Equation for torque under running conditions. -Draw torque - slip curves. -Relationship between full load torque and maximum torque, starting torque and maximum torque</p> <p>2. Explain Equivalent circuit of an induction motor.</p> <p>3. Relationship between rotor power input, rotor copper loss, and Mechanical power developed and slip. -Problems on the above.</p>	Refer Table1	<p>Follow Safety rules and Safe working practices</p> <p>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)</p> <p>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.</p>
4	1	1,4	<p>1. Starters: Necessity of starters and list the various types of starters. Main criteria for the selection of the starting method.</p>	Refer Table1	<p>1a. Identify the parts of a DOL starter, test its parts, locate faults if any. Suggest remedies.</p>

			<p>2a. Construction, working and troubleshooting of D.O.L. Starter. 2b. Construction, working and troubleshooting of star-delta Starter.</p>		<p>1b. Connect, Start, Run and Reverse the direction of rotation of 3-phase Induction Motor using DOL starter. Ref.7(7)</p>
			<p>3a. Construction and working of Soft Starter. 3b. Maintain, service and troubleshoot the AC motor starter</p>		<p>Follow Safety rules and Safe working practices.</p> <p>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</p>
5	1,3	2,4	<p>1. Speed Control of induction motor: - Change of applied voltage method. - Change of number of poles.</p>		<p>Follow Safety rules and Safe working practices.</p> <p>1. Speed control of IM using any one method, Use of Power Quality Analyzer & Motor Analyzer to measure various parameters.</p>
			<p>2. Speed Control of induction motor: - Change of frequency - Rheostat control method.</p>	Refer Table1	<p>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)</p>
6	1	1,4	<p>1. Synchronous Motors: Working principle, construction, and method of starting of synchronous motor. -Compare the synchronous motor with the induction motor.</p>		<p>Follow Safety rules and Safe working practices</p> <p>1. Start, Run and Reverse the direction of rotation of the synchronous motor.</p>
			<p>2. Effect of increased load with constant excitation. - Effect of change in excitation at constant load.</p>	Refer Table1	<p>2. Plot V and inverted V curves for synchronous motor, Use Power Quality Analyzer & Motor Analyzer.</p>
			<p>3. Effect of excitation on armature current & power factor.</p>		

7	1	1,2,4	1. Effect of excitation on leading, lagging and zero power factor.	Refer Table1	1. Demonstrate troubleshooting of synchronous motors.
			2. Synchronous condenser and its application. Ref.7(19).		2. Case study of Synchronous condenser.
			3. Hunting and phase swinging, losses and methods of starting of synchronous motors.		
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.	Refer Table1	1. Demonstrate different protection classes.
			2. Synchronous reluctance motors. Ref.7(22).		2a. Demonstrate Installation of synchronous motor and Induction motor. 2b. Perform general preventive maintenance of sync motors. Ref.7(20,21)
			3. Procedure for Installation and Maintenance of sync motors and Induction motor.		
9	1	1,4	1. Single-phase motors: Working principle, construction and characteristics. Ref.7(28).	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. Resistance Split phase motor -Capacitor Start Induction motor.		2. Perform general preventive maintenance of 1-ph Induction Motors.
			3. Working Principle & characteristics of Induction Generators and its applications.		
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.	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. 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)		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

			<p>-Select a motor for a given industrial application. Ref.7(12,13,14)</p> <p>2 Motor testing tool for energy efficiency. Ref.7(25,26,27)</p> <p>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.</p>	<p>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)</p> <p>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.</p>
12	4	3,4	<p>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)</p> <p>2.Parts of a contactor, number of NOs, NCs, nature of coil supply AC/DC, voltage ratings and current ratings.</p> <p>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.</p>	<p>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</p> <p>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)</p>
13	4	3,4	<p>1.Draw a control circuit for forward and reverse operation of a motor with interlocking function using combined auxiliary contact and push buttons.</p>	<p>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.</p>

		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	<p>Study Totally enclosed squirrel cage single-phase low voltage motors, Sizes 56 - 100, 0.065 to 2.2 kW.</p> <ol style="list-style-type: none"> 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	<p>Study electric motors used in Electric vehicles.</p> <ol style="list-style-type: none"> 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	<p>Study the case "World's largest multi-stage water pumping stations project designed to bring much needed water to the Indian state of Telangana."</p> <ol style="list-style-type: none"> 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 <p>https://new.abb.com/drives/media/kaleshwaram-lift-irrigation-system-abb-success-story https://www.youtube.com/watch?v=5wXOSVCHf38</p>
11	12	<p>Study the case "Mahatma Gandhi Kalwakurthy Lift Irrigation Scheme"</p> <ol style="list-style-type: none"> 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 <p>https://new.abb.com/news/detail/4291/abb-pumping-technology-helps-rescue-parched-farms-and-villages-in-india</p>
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	Descriptor	8
2	Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	6
3	Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2
4	Descriptor	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.Gupta 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	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/emsatools/
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/58b63ea623ddaf9c125786800278df5/56-61%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 ii. Build the circuit as per the circuit diagram iii. Demonstrate the performance/operation of a motor iv. Document the necessary readings of the expected outcome	10 10 25 05	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 ii. Build the circuit as per the circuit diagram iii. Demonstrate the performance/operation of a motor iv. Document the necessary readings of the expected outcome	05 10 15 05	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
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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 ii. Build the circuit as per the circuit diagram iii. Demonstrate the performance/operation of a motor iv. Document the necessary readings of the expected outcome v. Comply with standard safety norms related to electrical motors	10 10 20 05 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)
					1 hour / 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.	Refer Table 1	1.Test the given SCR for its working condition.
			2. Static V-I characteristic curve of SCR, Enumerate Reverse blocking, Forward blocking, forward conduction mode.		2. Simulate VI characteristics of SCR, GTO and LASCR.
			3. GTO, principle of operation and list its application, layer structure of LASCR and explain its operation.		
4	1,2	1,4	1. Layer structure, operation and characteristics of TRIAC	Refer Table 1	1a. Test the given TRIAC and DIAC for its working condition. 1b. Simulate VI characteristics of TRIAC and DIAC.
			2. 4-Modes of turn on of TRIAC and state the preferred mode of turn-on.		2.Build and test a TRIAC- fan motor speed control circuit.
			3. Operation of DIAC and its V-I characteristic, curve, application of DIAC.		
5	1,2	3,4	1. SCR Control Circuits: Methods of turn on of SCR	Refer Table 1	1.Build R firing circuit and determine the maximum firing angle.
			2. General layout of firing circuit.		2. Build R – C firing circuit and determine the maximum firing angle.
			3. R firing circuit and R-C firing circuit with waveforms.		
6	1,2	3,4	1. Construction, operation and characteristics of UJT	Refer Table 1	1.Build and test UJT Relaxation oscillator.
			2. Synchronized UJT pulse trigger circuit with waveform.		2. Build and Test time delay relay using SCR and UJT.
			3. Digital firing scheme with waveforms.		
7	1,2	3,4	1. Commutation, line commutation, forced commutation and methods of forced commutation, Load commutation and complementary commutation.	Refer Table 1	1.Simulate Line commutation and forced commutation circuits and observe waveforms.
			2. Voltage and current ratings of SCR and Reliability of SCR, MTBF.		2. Construct a snubber circuit for protecting SCR use freewheeling diode to reduce back emf.
			3. How SCR can be protected against overvoltage and over current, di/dt & dv/dt . Different types of mounting of SCR.		
8	1,2	4	1. CONVERTERS: types of power electronic converters: Single -quadrant semi-converter, two- quadrant full- converter and dual converter.	Refer Table 1	1.Build single-phase full controlled bridge converter for resistive load. Trace the waveforms across SCR and load.
			2. Single-phase full converter RLE type with continuous load current		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.	Refer Table 1	1.Test three-phase bridge rectifier module (36MT160)
			2.Three-phase bridge converter and 180 conduction mode with waveforms.		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.	Refer Table 1	1.Simulate/Build step-down chopper and observe waveforms.
			2. Different chopper configurations- (A, B, C, D and E).		2. Simulate / Build step-up chopper and observe waveforms.
11	1,2	4	3. Inverter- Types of inverters (VSI and CSI).		
			1. Half bridge and full-bridge inverter and its operation.		1.Simulate Full-bridge Inverter and observe waveforms.
			2. Cycloconverter- Draw the circuit of mid- point Step-down cyclo-converter and its operation with 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).	Refer Table 1	1a. Build & test IC based - DC –DC converter for different voltages. Ref.7(8)
			2. Working principle of Boost converter (regulator). Ref.7(9,10,11,12)		1b. Test the monolithic synchronous buck regulator (MP2305).
			3.Working principle of Buck-boost and flyback converter. Ref.7(14,15,16,17)		2.Test and Troubleshoot regulators. Ref.7(13)
13	2,3	2,3,4	1. SMPS and its operation and application.		1a. Identify various input and output sockets/ connectors of the given SMPS.
			2. UPS, Battery size and required voltage for UPS		1b. Identify major sections/ ICs/components of SMPS.
			3a. Draw the block diagram of offline online UPS and its operation. 3b. List basic troubleshooting steps for UPS. Ref.7(21,23)		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 $\eta = 0.63$, $V_{BB} = 20$ V, $V_P = 13.2$ V, $I_P = 50 \mu\text{A}$ $V_V = 2$ V, $I_V = 6$ mA, $R_{BB} = 7$ k Ω , 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	<p>1.Explain advantages and disadvantages of power electronic converters.</p> <p>2. Study Industrial rectifiers</p> <ol style="list-style-type: none"> 1) List Types of Industrial rectifiers and their applications 2) Typical specifications of commercially available rectifiers 3) Cooling methods employed in rectifiers.
9	9	<p>Study given Standard Rectifier Module (VUO190-16N07)</p> <ol style="list-style-type: none"> 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 <p>Study Industrial rectifiers</p> <ol style="list-style-type: none"> 1) List Types of Industrial rectifiers and their applications 2) Typical specifications of commercially available rectifiers 3) Cooling methods employed in rectifiers
10	10	<p>Study the Intelligent Power Module (STK551U3A2A-E)</p> <ol style="list-style-type: none"> 1. Explain features of Intelligent power module 2. List applications of Intelligent power module 3. Explain rating of given IPM
11	11	<p>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"</p> <ol style="list-style-type: none"> 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=4IQBN60y8Lg
10	https://www.youtube.com/watch?v=Rf29oUGpwI
11	https://www.youtube.com/watch?v=vmNpsofY4-U
12	https://www.youtube.com/watch?v=yD7fMyIYgXw
13	https://www.youtube.com/watch?v=-3tBw6WSZVM
14	https://www.youtube.com/watch?v=zNfbPobtus
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-B6006GB8https

18	https://www.youtube.com/watch?v=6CsTIPjFZ48 www.youtube.com/watch?v=l8c5DLJgS3o
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=IkriUIUdfIM 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 ii. Build the circuit as per the circuit diagram iii. Demonstrate the working of the circuit. iv. Document the necessary readings of the expected circuit outcomes.	05 10 20 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 ii. Identify and explain the Data Sheets for the given power Electronic Devices. iii. Demonstrate the working condition of power electronics devices. iv. Build the circuit as per the circuit diagram v. Demonstrate the working of the circuit. vi. Document the necessary readings of the expected circuit outcomes.	10 10 10 15 20 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	<p>1.Sensors: operation, characteristics and application: Inductive Proximity Sensors, Magnetic Proximity Sensor.</p> <p>2. Capacitive proximity sensors, Optical proximity sensors, Ultrasonic proximity sensors</p> <p>3. Linear Position sensors, Photoelectric sensors. Infrared sensors Limit Switches.</p>	Refer Table 1	<p>1a. Identify and test different sensors. 1b. Select a suitable proximity sensor for a given application and wire up the same. Ref 7(2)</p> <p>2.Develop a relay-based motor control automation such that the motor reverses its direction when the limit switches are activated.</p>
4	1	4	<p>1. Inductive linear transducer, area sensors, flow sensors Ref.7(1)</p> <p>2. Temperature sensors, colour sensors, Hall effect sensor</p> <p>3a. Pressure sensors -Electronic pressure switches with binary output signal. 3b. Concept of Sensor latching. Latching Digital Hall effect sensor.</p>		<p>1.Identify and test different sensors.</p> <p>2. Simple Hall effect sensor Latching ON/OFF Relay switch Circuit.</p>
5	2	1,4	<p>1. Fundamentals of pneumatics- Individual components in a pneumatic control system and their functions. Ref.7(1)</p> <p>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.</p> <p>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</p>	Refer Table 1	<p>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/Solenoid valve c. Identify industrial applications of Single acting and Double acting cylinder. Ref 7(3,4)</p> <p>2 a. Speed control of single-acting cylinders by flow control valve b. Speed control of double-acting cylinders by flow control valve</p>
6	2	1,4	<p>1. Functions and features of pneumatic drives- Guided cylinders, rodless linear drives and rotary drives. Ref.7(1)</p> <p>2. Pneumatic grippers.</p>	Refer Table 1	<p>1. Demonstrate the use of Pneumatic drives (used in small robots)</p> <p>2. Demonstrate the use of Pneumatic grippers.</p>

			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.	Refer Table 1	1. Activate the DC motor using 2 relays to run the motor forward and backward direction.
			2. Activating DC motors		2. Install and control speed of 3-ph motor using VFD.
			3. Working principle of Variable frequency drive.		
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)	Refer Table 1	1. Demonstrate open loop and closed systems observed in everyday life.
			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.		2. Demonstrate Industrial applications of PLC
9	3	1,4	1. Programmable logic controllers- Internal architecture and functional structure. Input/output modules.	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
			2a. List input / output devices of PLC. -List types of PLC. 2b. Functions of Programming equipment (Programmer/monitor)		2.Identify and Install Programming Software and communication driver.
			3a. Explain PLC Programming Languages –Ladder diagram/ Functional Block Diagram /Instruction List/structured text. 3b. Explain scope of IEC standard for PLC: IEC 61131		
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.		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)
			2.Configuration of I/Os and Addressing I/Os, study of PLC symbols.		

			<p>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.</p>		<p>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)</p> <p>2. Develop and test the ladder program for interlocking two motors, using PLC simulation software.</p>
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.
			2.Describe Timer instructions and their application: Describe Timer On Delay (TON), Timer Off Delay (TOF), Retentive Timer On (RTO)		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.
			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		<p>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.</p> <ul style="list-style-type: none"> 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	
		3.Wiring PNP 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.
13	4	1.Meaning of SCADA -Functions of each component of SCADA system, -Describe SCADA Hardware and software -Applications of SCADA. 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.	Demonstrate application of SCADA/HMI/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	<p>Study time relay</p> <ol style="list-style-type: none"> 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	<p>I. Study LVDT</p> <ol style="list-style-type: none"> 1. Explain working principle of LVDT 2. List the applications of LVDT 3. List the benefits of LVDT <p>II. Develop an automatic door system using optical sensor and linear actuator. https://www.instructables.com/Automatic-Door-Opening-and-Closing-System-Using-IR/</p>
4	4	<p>Study digital Hall effect sensor (SS361RT, SS461R).</p> <ol style="list-style-type: none"> 1. List features of Hall effect sensor 2. List applications Hall effect sensor 3. Explain electrical characteristics of Hall effect sensor
5	5	<p>I. List the advantages of pneumatics and explain application of pneumatics in automation.</p> <p>II. Problem statement:</p> <p>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.</p> <ol style="list-style-type: none"> 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	<p>I. For the given application (Sorting device for metal stampings)</p> <ol style="list-style-type: none"> 1. Suggest Suitable pneumatic cylinder 2. Draw circuit diagram <p>II. For the given application (separating parcel post)</p> <ol style="list-style-type: none"> 1. Suggest Suitable pneumatic cylinder 2. Draw circuit diagram <p>III. For the given application (Quarry stone sorter)</p> <ol style="list-style-type: none"> 1. Suggest Suitable pneumatic cylinder 2. Draw circuit diagram
7	7	<p>Study given commercially available VFD</p> <ol style="list-style-type: none"> 1. List its features 2. Applications of VFD 3. Explain specification of VFD 4. Types of VFD available in the market.
8	8	<p>Study PLC based sand mixing Machine</p> <ol style="list-style-type: none"> 1. Explain sequence of operation 2. Draw and explain the relay Ladder Logic diagram 3. Draw and explain the Ladder diagram
9	9	<p>Study LIFT Control using PLC</p> <ol style="list-style-type: none"> 1. Explain sequence of operation. 2. Draw and explain the Ladder diagram.
10	10	<p>Study PLC Conveyor Motor Ladder Logic</p> <ol style="list-style-type: none"> 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
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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	Descriptor	8
2	Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	6
3	Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2
4	Descriptor	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	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 ii. Build the circuit as per the circuit diagram iii. Demonstrate the operation of a Pneumatic actuators	05 10 20	3 35
6	Viva voce		10
Total Marks			100

8.2 CIE-5 Skill Test Scheme of Evaluation

SL. No.	Particulars/Dimension	C O	Mark s
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
	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		
3	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,	Tutorial hours shall be used to practice drawings.	Practice the basic CAD commands. Ref.7(1,2,3,4,5)
			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		
2	1,2	1,4	Single line diagram of 110 KV/11KV MUSS	Tutorial hours shall be used to practice drawings.	1. Single line diagram of 110 KV/11KV MUSS. Ref.7(10,11)
			Single line diagram 11KV of Substation		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	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 and Create BOM (Bill of Material): Electrical wiring of a small workshop		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
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=pvKVs-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=ZRXIWoT-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=pQlfLt4RiUOsM
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=XsKbtm60tAw
18	https://www.youtube.com/watch?v=fX0wgNYT0hg
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 ii. Labelling iii. Indexing	20 10 10 40
2	Assembly drawings Sectional end view and front elevation (Front elevation and plan in case of transformer) i. Use of suitable commands ii. Sectional end view/ front elevation iii. Front elevation/plan iv. Dimensioning v. Labelling	10 15 10 10 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. i. Develop winding table ii. Draw sequence diagram iii. Mark the poles iv. Show the direction of induced emf and indicate the position of brushes and show the direction of current. OR Single line diagram Draw the single line diagram of a MUSS/substation i. Use of suitable commands ii. Labelling iii. Indexing	1,2	40
2	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 ii. Labelling iii. Indexing		
3	Assembly drawings Sectional end view and front elevation (Front elevation and plan in case of transformer) i. Use of suitable commands ii. Sectional end view/ front elevation iii. Front elevation/plan iv. Dimensioning v. Labelling OR 3D Drawing- Squirrel cage Induction motor. i. Use of suitable commands ii. Labelling iii. Indexing	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	<ul style="list-style-type: none"> ● 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, Bruhat 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