Government of Karnataka

DEPARTMENT OF COLLEGIATE AND TECHNICAL EDUCATION

Program	Electrical & Electronics Engineering	Semester	5
Course Code	20EE52I	Type of Course L:T:P	Integrated 104:52:312
Specialization	Power Engineering	Credits	24
CIE Marks	240	SEE Marks	160

Introduction: Power engineering, deals with the generation, transmission, distribution, and utilization of electric power, and the electrical apparatus connected to such systems. The power engineering course is taught in Boot camp mode. Boot camp are 12 weeks of intense learning sessions designed to prepare the students for the practical world – ready for either industry or becoming an entrepreneur. Students will be assisted through the course, with development-based assessments to enable progressive learning. Power engineering introduces Smart Grid, Energy auditing, SCADA and IoT. This specialization enables the student to install, commission, test and maintain an EV charging stations. Students are also exposed to power quality issues in Data canters and ways to mitigate them.

Pre-requisite

Before the start of this specialisation course, student shall have prerequisite knowledge gained in the first two years on the following subjects:

1st year – Engineering Mathematics, computer Aided Engineering Graphics, Fundamentals of Electrical and Electronics Engineering and Basics of Electrical power system, Communication Skills, Statistics & Analysis, Basic IT Skills, Project Management skills and Residential wiring.

2nd year- Transformers and Alternators, Transmission and Distribution, Switchgear and Protection, Analog and Digital electronics, Electrical motors, Power electronics, Fundamentals of Automation Technology and Computer Aided Electrical Drawing.

In the third year of study, student shall be applying previous years learning along with specialised field of study into projects and real-world applications.

Course Cohort Owner

A Course Cohort Owner is a faculty from the core discipline, who is fully responsible for one specialised field of study and the cohort of students who have chosen to study that specialised field of study.

Guidelines for Cohort Owner

1. Each Specialized field of study is restricted to a Cohort of 20 students which could include students from other relevant programs.
2. One faculty from the Core Discipline shall be the Cohort Owner, who for teaching and learning in allied disciplines can work with faculty from other disciplines or industry experts.

3. The course shall be delivered in boot camp mode spanning over 12 weeks of study, weekly developmental assessments and culminating in a mini capstone.
4. The industry session shall be addressed by industry subject experts (in contact mode/online / recorded video mode) in the discipline only.
5. The cohort owner shall be responsible to identify experts from the relevant field and organize industry sessions as per schedule.
6. Cohort owner shall plan and accompany the cohort for any industrial visits.
7. Cohort owner shall maintain and document industrial assignments, weekly assessments, practices and mini-project
8. The cohort owner shall coordinate with faculties across programs needed for their course to ensure seamless delivery as per time table
9. The cohort owner along with classroom sessions can augment or use supplemental teaching and learning opportunities including good quality online courses available on platforms like Karnataka LMS, Infosys Springboard, NPTEL, Unacademy, SWAYAM, etc.

Course outcome:

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

CO1	Select and demonstrate the appropriate charging methods for a given EV.
CO2	Install, test and commission the EV charging station and evaluate the charging capabilities of the EV charging station.
CO3	Measure, Monitor, and control power in an electrical utility.
CO4	Perform an energy audit of a given building /industry and suggest suitable energy-saving measures.
CO5	Analyze the power quality issues in a data center and suggest suitable remedies.

Detailed course plan

Week	CO	PO	Days	1st session (9am to 1 pm)	L	T	P	2ND session (1.30pm to 4.30pm)	L	T	P
1	3	1	1	**Introduction to power engineering** • Growth of the Power sector in India and globally. • Role and importance of power sector organization in India • Central sector: NTPC, CEA, power grid, NLDC • Private: Tata Power, Adani, Reliance, ABB, Jindal • State sector: KPC, KPTCL, ESCOM's • Organization structure of the power sector including. - installed capacity India/Karnataka. • Virtual tour of NTPC, Power grid NLDC, Tata Power, Adani, Reliance, ABB, Jindal ,etc., **Collect following data and present** • Category wise (thermal, hydel, nuclear, and renewable) Installed capacity -Indi , Karnataka • Daily generation • Growth of electricity generation in India • Growth of Electricity consumption • (%) Towns where AT&C loss reduced • Transmission Lines (CKm) • Transformation Capacity(MVA)	1		3	**Term: Decarbonization:** How Does Decarbonisation Work? Why is Decarbonisation Important? How do we Decarbonise? NetZero: Meaning of NetZero, the difference between NetZero and zero. Sustainability Carbon footprint calculator Calculate your family's carbon footprint. **Ref 1b** Importance of Power positive **Ref 1c**	1		2

				• Growth of Transformation capacity (MVA) and transmission lines (CKm) **Ref 1g**							
	3	1	2	Power Transmission: • Present power transmission network: Transmission system details of India Collect the following data and present • Completed Transmission systems • Upcoming Transmission projects • Transmission systems under construction **Ref 1d** Entities of power transmission: • Central: Power Grid, NLDC • State: KPTCL, SLDC. Power Transmission system development/future plans • HVAC transmission • HVDC transmission • Benefits of HVDC transmission Reduction in land for substation – GIS Transmission Loss Power Distribution: • HV distribution – Industrial • LV distribution – Irrigation, domestic. • Distribution entities – ESCOM's Distribution loss – AT&C loss	1		3	**Regulating Authorities:** Role of regulating authorities in power system. Regulating Authorities: ❖ Central: CEA, CERC ❖ State: KERC • Indian Grid code • Different tariff structure • Demonstrate Power system operation • Power/Energy demand (Peak/Non-Peak) • Demonstrate Role of LDC in power system operation. • Power Dispatch – Declaring, scheduling, Un-scheduled Interchange (UI)	2		1

				• Billing efficiency and collection efficiency • Action Plan for Billing efficiency and collection efficiency Improvement. • Problems on AT & C losses Collect following data and present AT &C Loss % of ESCOMS **Ref 1f** Glossary of key terms: Average Cost of Supply (ACS), Average Revenue Realised (ARR), AT&C losses, Cross-subsidy, DISCOM/ Distribution utility, Energy deficit, Peak deficit, Plant Load Factor (PLF), Power Purchase Agreement (PPA): Smart Grid, Tariff petitions and orders							
		1	3	**Design thinking** What is design thinking? 5 steps of Design Thinking. **Ref:1j** Why is design thinking so important? **Ref:1k**	2		2	**Examples of design thinking Ref:1L**	1		2
		1	4	Applying Design Thinking to Sustainable Energy. **Ref:1M**			4	How can 'Design Thinking' help utilities prepare for a new energy future? **Ref:1N**			3
			5	**Developmental Assessment**	-	-		**Assessment Review and corrective action**			3
			6	**Industry Class + Assignment**	**2**		**3**				

Week	CO	PO	Days	1st session (9 am to 1 pm)	L	T	P	2ND session (1.30 pm to4.30 pm)	L	T	P
2	1	1	1	**Peer discussion on Industrial assignment.**		4		**Fundamentals of electric vehicle charging technology and its grid integration:** **Key Terminologies used in the EV Ecosystem:**	2		1

								Electric Vehicle (EV), Battery Electric Vehicle (BEV), Hybrid Electric Vehicle (HEV), Hybrid Electric Vehicle (HEV), Plug-in Hybrid Electric Vehicle (PHEV), Charging Station/ Electric vehicle Charging Station (EVCS), Charging Point/ Electric Vehicle Supply Equipment (EVSE), Charging Pool, Connector, Charge Point Operator (CPO). Types of Electric vehicles, types of Engines Stakeholders in EV Ecosystem **Ref 1** **EV cost calculator** • Home charging calculator • Public charging calculator • Journey cost calculator • Co2 emission calculator • Tax saving calculator • Crude oil saving calculator **Ref 1h**			
	1	4	2	**Charging technologies for Electric Vehicles:** • Classification of EV charging technologies • EV charging infrastructure classification **Conductive (Plug-in/Wired) charging:** • Modes of Charging (IEC 61851 standard) • Charging levels as per IEC 62196, IEC 61851, and SAE J1772	2		2	**Technical Details of EV charger**: • Electric Vehicle battery charger components. • Block diagram of on-board EV charger, • Demonstrate (Video/ physical) EV charger components • Identify different EV charger components **Ref 1**	1		2

				• Comparison between charging levels • Demonstrate (Video/physical) different EV charging technologies • Demonstrate (Video/physical) different modes of charging. **Ref1**							
	1	4	3	**Converters and control for EV** • charging: Level 1, Level 2, and Level 3 charging • Block diagram and electronics inside an EVSE • Pilot Wire Communication Standard • Identify charging level (1,2,3) for given electric vehicle (Two-wheeler/Three-wheeler, Car/ Bus)	2		2	**Level 3 charging:** • Block diagram of DC charging station. • Communication and power flow between EV and EVSE: • DC charging station AC/DC converter and control • DC charging station DC/DC converter and control • Identify different components of the DC charging station	2		1
	1	4	4	• Charging speed **Connector Types** • Type 1/Yazaki (SAE J1772, IEC 62196-1) • Type 2 (IEC 62196-2) • Combined Charging System (CCS 1) • CHAdeMO • Combined Charging System (CCS 2) • GB/T DC Charger • Tesla Supercharger • Selection of charger for given vehicle type, power rating, and voltage. **Ref 2b** • Identify different EV charging connectors.	1		3	• EV Wireless charging standards, • Battery specifications of different EV segments. **Ref 2a** Battery swapping • Types • Battery swapping station and components **Ref1** • Selection of AC charger type-1, type -2, and type -3 • Selection of DC charger connector GB/T, CHAdeMO, CCS-1, and CSS-2 • Selection sizing of Charger connector cable Technical specification and features of DC chargers • DC charger 30KW	1		2

				The Indian standards of charging connectors are derived from the international standards • Bharat AC-001 • Bharat DC 001 Practical conductive charging power curves. **Wireless Charging:** • Inductive WPT: Block diagram of Inductive wireless power transfer • Capacitive WPT: Block diagram of Capacitive wireless power transfer **Ref 1** • Demonstrate (Video) Inductive WPT • Demonstrate (Video) capacitive WPT **Ref 1a**				• DC quick charger 100kW **Ref 2c**			
			5	**Developmental Assessment**	-	-		**Assessment Review and corrective action**				3
			6	**Industry Class + Assignment**	**2**		**3**					
3	1	1	1	**Peer discussion on Industrial assignment.**		4		**Standards for EV Charging** **International Standards:** • IEC 61851, • SAEJ1772, • IEC 61980, • SAE J1773, • SAE J2954, • GB/T 20234 **Plug, Connector, And Socket Standard:** • IEC 62196	2			1

								• Sections in IEC 62196 standard • Miscellaneous: EC 60364, SAEJ2293, SAEJ2836, SAEJ2931, SAEJ2954, IEEE1547, NFPA 70, SAEJ2836 **Ref 1**			
	1	1,4	2	**Indian Standards:** **AIS 138 part 1: Electric vehicle conductive AC charging:** **AC slow charging:** • AC slow charging with a separate charger • AC slow charging with an On-board charger • On-board charger with fixed cable • Demonstrate AC slow charging method **AC fast charging mode** • AC fast charging with free cable • AC fast charging with fixed cable • Mandatory and optional safety functions while AC conductive charging • Pin information of IEC 60309 and IEC 62196 • Connector- IEC 60309 • Full form of connector pins in IEC 60309 • Connector- IEC 62196 • Full form of connector pins in IEC 62196	2		2	**Charging protocols for EV charging:** • CHArge de MOve (CHAdeMO) Protocol, • Tesla Charging Protocol, Diagram of Tesla supercharger connector • Combined Charging System (CCS) -Connection pins in CCS1 connector -Connection pins in the CCS2 connector • Type 2 AC charging -IEC type-2 connector • Bharat Charging Standards -Bharat AC 001 - Bharat DC 001 • Identify type 1 plug and socket • Identify type male 2 plug and socket • Type 2 Female Plug & Socket **Ref1** **DC charging cable** When To Use AC And DC Charging for Charge Electric Vehicle? **Ref 4** **Ref 2**	2		1

				• Cable assemblies for AC slow and fast conductive charging • **Demonstrate AC Fast charging method** **AIS 138 part 2: Electric vehicle conductive DC charging system** • Types of EVSE **Plug, Socket, Connector:** • IS 17017 part 2/ section 2, • IS 17017 part 2/ section 3, • Safety Standards. **Ref 1** **Ref 2** **How to choose the type of plug for a charging** Type1 and type2 cables Choosing right cable for your car **Ref 3**								
	1	1,4	3	**Safety Standards of Electric Vehicle Charging Station:** The safety aspect of charging station • Electrical safety • Functional safety • Battery charging safety • Maintenance and operation safety. **Setting up an EV charging station** • What is a Charging Station? • Working of Charging Station. • Components of Charging Station. • Types of Charging Station. **Ref 5** • Classification of EV charging infrastructure	2		2	**Setting up an EV charging station** • What is a Charging Station? • Working of Charging Station. • Components of Charging Station. • Types of Charging Station. **Ref 5** • Classification of EV charging infrastructure • Policy-making and regulatory authorities **Ref 6** • Identify components of the charging station • Demonstrate working of charging station	1		2

				• Policy-making and regulatory authorities **Ref 6** **Assessing Charging demand :** • Steps for the EV charging demand assessment and charging infrastructure estimation. • Demand-based target setting for EV charging infrastructure in your city (Bengaluru) **Ref 6**							
	1	1,4	4	**Arranging for electricity supply for charging** **Ref 6** **Case-based demonstration:** An EV owner has identified a location for setting up a standalone charging facility and wants to install two 50 kW chargers, three 7 kW chargers, and a 9-unit stack battery charging system. After consulting the DISCOM, it is found that the nearby DT has available capacity to support an additional load of 48 kW, beyond which its capacity would need to be augmented. Moreover, the supply code stipulates 7 kW and 65 kW as the maximum sanctioned load limits for single-phase LT and three phase LT electricity connections, respectively. What is the optimal connection type and configuration for the charging facility? **Ref 6**			4	• Identify Charging options for various vehicle categories • Government guidelines for Setting EV Charging Stations **Ref 11** • State Government Policy **Ref 12** SMART EV CHARGING • Back-end architecture for smart charging • Communication protocols for smart charging **Ref 6** **Ref 2** Integrating EV charging in grid planning • Impact of EV charging on power demand **Ref 6** • Impact of EVs on the Distribution Feeder • EV Load Impacts on Electricity Generation Adequacy	1		2

				• How to set up an EV charging station **Ref 7** • Minimum requirements of public charging Infrastructure (PCI) • Benefits of setting up an Electric car charge station. **Ref 8** **Cost Estimates for a Typical Public Charging Station (PCS)** **Ref 9** **Ref 10**				• EV Load Impacts on Distribution Grid Equipment • EV Load Impact on Power Quality **Ref 2** • Demonstrate impact of EV on Distribution feeder . • Demonstrate impact of EV on Power Quality			
			5	**CIE 1– Written and practice test**	-	-	-	**Assessment Review and corrective action**			3
			6	**Industry Class + Assignment**	**2**		**3**				

4	2	4	1	**Peer discussion on Industrial assignment.**		4		**Preparation for installation** • Employ practice of inspecting the site for all requirements for the erection and installation of an EV charging station. • Demonstrate the unpacking of the EV charging machine and checking for the presence and functionality of all components, like the transformer, electric kiosks, lines/cables, and associated equipment. • Determine the appropriate length of the charging cable and circuit breaker based on-site, charging station, and customer requirements			3
	2	4	2	**Erection of EV charging station**	2		2	• Demonstrate the process of installing conduits for carrying electrical wires, and cables from			3

				• List the various types of electrical sources/facilities for energizing the charging station. • Explain the process of cabling from electrical facilities such as DISCOM utility, micro-grid systems, solar panels, etc. to the place of installation of the charging station. • Discuss the importance of putting identifiable marks on the civil foundation for charging station erection.				nearest source/facility to the charging station. • Assign markings on the civil foundation for charging station erection after taking measurements.			
	2	4	3	**Erection of EV charging station** • Describe the importance of manufacturer guidelines in unpacking the EV charging station. • Detail the technique to be followed to ensure proper erection and positioning of the charging station. • Discuss the factors to decide the number of rectifiers to be installed in the charging station. • Explain the considerations for a number of charging guns at the EV charging station.			4	• Demonstrate the fixing of the EV machine on the civil foundation while ensuring a firm grip. • Employ operating of appropriate tools and equipment such as drilling machine, screwdriver set, socket wrench, hammer, washers, nuts; various types of mounting and insertion tools etc. as per the type of task to be performed pertaining to EV charging station installation.			3
	2	4	4	**Installation of EV charging station** • Discuss the relevant IS and IEC standards applicable to the EV charging station installation. • State the importance of disconnecting the power	2		2	**Installation of EV charging station** • Demonstrate the installation of a rectifiers for each charging guns in the EV charging station. • Demonstrate the installation of earth protection system and AC/DC			3

				supply connections before installation. • Elaborate on the technique to connect the power supply to the main switches and/or installation blocks. • State the importance of residual current device in an EV charging station • Explain the various types of cable routing techniques such as surface cable routing, and flush-type cable routing within a charging station. • Discuss the purpose and installation procedure for the software and communication protocols. • Explain the various types of protection to be provided to the charging such as weather protection, protection against voltage fluctuations, safety tests, etc.				power modules in the EV charging station in line with IS and IEC standards applicable to EV charging station installation. • Demonstrate the process of installing a residual current device (RCD) or fault current circuit breaker in compliance with the specifications of the charging station. **Installation of EV charging station** • Employ configuring of password authentication and licensing software in the charging station. • Demonstrate the installation of the appropriate protocol for EV charging, such as Combined Charging System (CCS), GB/T, CHAdeMO (CHArge de Move), AC Charging etc. • Employ proper procedure for connecting and positioning the modem to the charging station to ensure effective GSM/CDMA connectivity.			
			5	**Developmental Assessment**	-	-		**Assessment Review and corrective action**			3
			6	**Industry Class + Assignment**	**2**		**3**				
5	2	4	1	**Peer discussion on Industrial assignment.**	-	4	-	**Testing the charging station** • List the various types of tests that are performed to test the EV charging station.	1		2

								• Explain the process to be followed to conduct various types of tests pertaining to the commissioning of an EV charging station. • State the key considerations to check the electrical connections for the charging station. • Elaborate on the technique for measurement of the voltage drop between various parts of the charging station. • Describe the steps to perform calculations for evaluating charging station characteristics and capabilities			
	2	4	2	**Testing the charging station** • Perform earthing tests following industry rules and regulations and standard work practices. • Test the connections of the conductive parts with the supply voltage source as per standard practice.			4	• Conduct tests to check for electrical continuity between exposed conductive parts and the earth circuit. • Apply the technique of measuring the voltage drop between the exposed conductive part and the earthing terminal of the charging station.			3
	2	4	3	**Commissioning of EV charging station** • Commissioning the charging station • Explain the procedure to rectify faults and equipment malfunction pertaining to the commissioning of the charging station. • Describe the need for modifications in the existing systems and installed devices. • State the importance of the installation and	2			• Demonstrate how to deal with equipment malfunction and rectify faults during the commissioning process. • Employ the process of modifying the existing systems and installing electrical devices as per requirements and test results. • Demonstrate the process to document backups, manuals, logs, etc. as per work requirements.			3

				commissioning certificate in the work process. • Explain the importance of ensuring that the site is cleared of all (electrical) debris, cleaned, and safe for people before leaving						
	2	4	4	**Grid Integration of EVs and its Impacts** • Voltage Stability Issues. • Phase Imbalance • Increase in Peak Load • Overloading, Power Losses. Power Quality: Conductor losses, Neutral Conductor, Motors and Generators, Transformers, Circuit Breakers and Fuses, Flicker: **Ref 1 and Ref 2** **Grid Support from EVs** EV charger application • Primary and secondary applications **Concept of Vehicle2X System** • Application of V2X Demonstrate • Vehicle to Grid(V2G) **Ref 13** • Vehicle to Home **Ref 14** Utilization of EVs for better RE Grid Integration **Ref 2**	2		2	• Vehicle to grid simulation using simulation software • Simulate/Develop a battery storage system using software/tools			3
			5	**CIE 2– Written and practice test**	-	-		**Assessment Review and corrective action**			3
			6	**Industry Class + Assignment**	**2**		**3**				

Week	C O	P O	Days	1st session (9 am to 1 pm)	L	T	P	2ND session (1.30pm to 4.30 pm)	L	T	P
6	3	1	1	**Peer discussion on Industrial assignment.**		4		**Introduction to SCADA:** • What is SCADA? • SCADA SYSTEMS • Evolution of SCADA • Objective of SCADA. • Benefits of SCADA • Functions of SCADA: • SCADA APPLICATIONS • Usage of SCADA, • Real-Time Monitoring and Control using SCADA **Ref 15**	3		
	3	1	2	**SCADA HARDWARE**: • SCADA Hardware Functions, • Remote Terminal Units (RTU): RTU Hardware: A typical single-board RTU. • Hardware functionality in an RTU, RTU Software functions • Basic operation: RTU Standards. • Difference between PLC and RTU • Features of SCADA **Ref 15** Demonstrate the difference between PLC and RTU **Ref 16** • Demonstrate the power measurement using a multifunction transducer.	2		2	**SOFTWARE AND PROTOCOLS.** • ISO MODEL, • DNP3 Protocol: Important Features of DNP3. • IEC60870 PROTOCOL The two widely used protocols for SCADA Applications : • HDLC (High-Level Data Link Control) • MODBUS The widely-used open software for SCADA systems : • Citect and Wonderware. **Ref 15**	2		1

				Ref 17 • Necessity of Intelligent electronic devices in power regulation. **Ref 18**							
	3	1	3	**Power system automation:** • Benefits of power system automation, • Structure of Power System Automation • Architecture for power system automation. Classification of Power system Automation: • Substation Automation • Distribution Automation **Ref 15** **Demonstrate** • Substation Automation • Distribution Automation	2		2	**Implementation of power system automation and protection using SCADA:** • Hardware Development. • Software Programming Simulation • SCADA-Based Model for Automation and Digital Protection **Ref 15**			3
	3	4	4	• Simple Digital System implementation in SCADA software. • Simple analog System implementation in SCADA software			4	Create SCADA Animation in SCADA software			3
			5	**Developmental Assessment**	-	-		**Assessment Review and corrective action**			3
			6	**Industry Class + Assignment**	**2**		**3**				
7	3	1	1	**Peer discussion on Industrial assignment.**		4		**Introduction smart Grid-1** • Meaning of smart Grid • Smart Grid - Analogy with Human Body **Ref 19** • DRIVERS FOR SMART GRID	2		1

								• Components of the electrical grid • History of the power grid • Evolution of power grid • Regulatory the authorities of the Indian energy sector • impact of the electrical grid • key figures of our country • Indian power scenario • Factors affecting the performance the of existing grid • What makes grid smart • smart grid conceptual model • Smart grid definition • Duties of smart grid • smart grid architecture • smart grid components **Ref 20** Why do we need a smart grid Is the smart grid a "Green grid" **Ref 20a** Virtual tour on Smart grid **Ref 20b**			
	3	1	2	Introduction smart Grid-2 • Power generation • Distributed generation • Transmission • Distribution • Smart information • Smart metering • Sensors • information management • smart communication • smart communication in the smart grid • Smart management	2		2	The architecture of smart grid system • Grid layout • customer domain • market domain. • service provider domain • operation domain • bulk generation domain • transmission domain **Ref 20** Tariff design for smart grid consumers • Time of day (TOD) / time of use tariff (TOU) • Critical peak pricing (CPP)	2		1

				• Smart protection system • challenges in smart protection system • Smart grid standards • Barriers to smart grid technologies **Ref 20** Demonstration of above Grid components				• Real time pricing • Return of smart grid investment through surcharges on consumers who are benefitted **Ref16** **Demonstration of TOD/TOU tariff**			
	3	1	3	Standards for the smart grid system • Smart grid standards • Classification of Smart grid standards **Ref 20** Use cases, lessons learned – pilot project experiences • The CESC, Mysore Smart grid pilot Project • Gujrat smart grid pilot project. • Electricity department, government of Puducherry **REF19**	2		2	**Elements and Technologies of smart grid system – I** • AMI (Advance Metering Infrastructure) • Smart meter –Block diagram • Benefits of Smart Meter • smart meter measurements • networking for AMI • Components of AMI • DA (Distribution Automation) **Ref 20** **Ref 19** Smart grid of tomorrow **Ref 21** Demonstration of AMI	2		1
	3	4	4	**Elements and Technologies of Smart Grid System- II** • SCADA Smart Metering • compare conventional and smart metering • Functional diagram of smart metering • signal acquisition • signal conditioning • ADC	2		2	Simulation of a sample smart grid **Ref 23**			3

				• Computation • Memory • Communication **Ref 20** Installation of smart meters Testing of smart meters **Ref 22**								
	3		5	**CIE 3 Written and practice test**				**Assessment Review and corrective action**			3	
			6	**Industry Class + Assignment**	**2**		**3**					
8	3	1	1	**Peer discussion on Industrial assignment.**	-	4	-	**Introduction to IoT** • main components used in IoT • ways of building IoT • Characteristics of IoT • Modern Applications Ref 24 a and Ref 24 b	1		2
	3	4	2	• **Communication devices in IoT** Needs for setting up IoT environment for basic applications 1. Choosing a platform for IoT development • AWS IoT: (Amazon Web Services) • Microsoft Azure IoT: 2. Choosing IoT hardware processor: • Arduino -Set up – procedure, Advantages: • Raspberry Pi - Set up – procedure, Advantages: • Need to use Bluetooth beacons	1		3	1. Simulate and Test blinking of LED using Arduino. 2. Simulate and test the dc motor using Arduino (i) clockwise & anti-clockwise rotation using Arduino. (ii) Speed control of dc motor using PWM 3. Measure voltage, current, and resistance using Arduino.			3

				Ref 25								
	3	4	3	Introduction to NODE MCU ESP8266 (WIFI module) **Ref 26** IoT-based Smart Energy Meter using NodeMCU ESP8266 Ref 27 a and Ref 27 b	1		3	Automate system to control appliances from anywhere through the internet. **Ref 28**			3
			4	What is Raspberry pi and why is it important for IOT **Ref 29** IoT-based Smart Energy Meter using Rasberry PI Rasberry PI • Use of Rasberry PI in IOT **Ref 30**	1		3	**Applying IoT technologies in the Electric Power Industry** • IoT applications: Energy Generation • IoT applications: energy transmission • IoT applications: Energy Consumption **Ref 31** IoT-Based Energy Management System **Ref 32** Benefits of Smart Energy Management using IoT (Internet of Things) **Ref 33a**			3
		5	**Developmental Assessment**		-	-		**Assessment Review and corrective action**			3
		6	**Industry Class + Assignment**		**2**		**3**				

9	**4**	1	1	**Peer discussion on Industrial assignment.**		4		**HVDS**: High Voltage Distribution system • Cost-benefit Analysis of HVDS • Implementation of HVDS ESCOMS in Karnataka Demonstration of HVDS system. **Ref33b**	1		2

	4	1	2	• Loss reduction by improving the ratio of HT/LT line in Electrical Distribution System High Voltage Distribution System (HVDS)-An Alternate for Improvement of Voltage Drop Profile • Open access in T &D • Electricity Act Provisions **Ref33b**	2		2	• Power Trading in Multi buyer and multi-seller environment • Availability-based tariff concept and importance • Balancing and settlement mechanism Demonstration of Power trading	1		2
	4	1	3	• Power trading rules in the changed scenario Role of Regulatory Commissions • Open Access challenges for Power Market • Power Exchanges and their functioning. • Market Based economic Dispatch (MBED) • Green Day Ahead Market (GDAM) Collect the following data and present • Exchange price • Power purchased from the exchange • State demand met • Shortage in MW **Ref 1c**	1		3	**Demand-side management** • Introduction • Types of DSM program • Benefits of DSM **DSM techniques** • load clipping • load shifting, • valley filling • Load Reduction • Strategic Load Growth • Flexible Load Shape **Ref 34a, 34b, 34c** Demonstration of different **DSM techniques** Demand-side management **Ref 35**	2		1
	4	2	4	• Agriculture side Demand-side Management **Ref 36 a and Ref 36 b** • Municipal demand side management (MuDSM): **Ref 37**	1		3	For a residential building suggest suitable energy efficient appliances for lighting, refrigeration, heating, and cooling. • Calculate energy saving Per annum using those energy-efficient appliances. • Saving of Co2 emission			3

				Demonstrate Ongoing DSM projects in Karnataka **Ref 38** Demonstrate DSM measures by Distribution Companies (DISCOMs) **Ref 39**				• Saving coal • Saving water				
			5	**CIE 4 Written and practice test**				**Assessment Review and corrective action**				3
			6	**Industry Class + Assignment**	**2**		**3**					
10	4	1	1	**Peer discussion on Industrial assignment.**		4		**ENERGY MANAGEMENT AND AUDIT** • Definition & Objectives of Energy Management • Need for Energy Audit • Types of energy audit • Preliminary Energy Audit Methodology • Detailed Energy Audit Methodology **Ref 40**	2		1	
	4	1,2	2	**Ten Steps Methodology for Detailed Energy Audit** Phase I -Pre Audit Phase Activities Phase II- Detailed Energy Audit Activities **Ref 40**	3		1	• Draw process flow diagram and list process steps; identify waste streams and obvious energy wastage Example: A flowchart of Penicillin-G manufacturing • Identification of Energy Conservation Opportunities • Technical and Economic feasibility **Ref 40**	3			
	4	4	3	• Classification of Energy Conservation Measures Energy Audit Reporting Format • Understanding Energy Costs	2		2	**Energy Audit Instruments** **Demonstrate use of following** • Electrical Measuring Instruments: • Combustion analyzer: • Fuel Efficiency Monitor: • Fyrite: • Contact thermometer: • Infrared Thermometer:	1		2	

				• Benchmarking and Energy Performance • Matching Energy Usage to Requirements • Best Operating Practices- lighting Common monitorable parameters and performance assessment • Motors • Transformers • Lighting system • Power generator set • Harmonic distribution at common coupling point(PCC) (https://beeindia.gov.in/content/publications-0 EC guidelines Explain motor load survey? Suggest Energy Conservation Measures for the different motor loading. Problems on energy audit				• Pitot Tube and manometer: • Speed Measurements: • Leak Detectors: • Lux meters: • Ultrasonic flow meter • TDS meter **Ref 40** **Energy Audit in ESCOMS** • 11 kV lines • Town audit • DTC wise audit **EESL (Energy efficiency services Limited) Mobile App** Present achievements of various EESL schemes • Energy saved per year (Mus) • Cost saving per year • Avoided peak demand in MW • Co2 reduction per year (million tonnes) **Ref 41** Calculate the annual energy savings and simple payback from replacing standard Existing motor with energy efficient motor versus rewinding the existing motor.			
	4	2,4	4	Perform energy audit of nearby Industry/Apartment/Commercial Complex/Malls and prepare			4	Perform energy audit of nearby Industry/Apartment/Commercial Complex/Malls and prepare a report as per standard format			3

				a report as per standard format							
			5	**Developmental Assessment**	-	-		**Assessment Review and corrective action**			3
			6	**Industry Class + Assignment**	**2**		**3**				

11	5	1	1	**Peer discussion on Industrial assignment.**	-	4	-	**Introduction to Data Centre** • Datacenter's growth trend • Present scenario and future growth of Datacenter's in India • Sources of Datacenter's power consumption. • Classification of Datacenter's Based on the Maximum IT Load • Typical Datacenter's power consumption architecture **Ref 42**	2		1
	5	2,4	2	Electrical requirements of Datacentres • Power flow in a Data centers • Calculating Total Power Requirements for Data Centers • Major components of electrical infrastructure Diesel Generator • Selection of DG set for Data centers application • Demonstrate Some energy-saving measures for DG sets Transformer is the gateway for the power to the Data centre	2		2	Transfer switch arrangement: Automatic Transfer Switches (ATS) • Schematic of Automatic Transfer switch Arrangement • Demonstration of ATS **Ref 42**	1		2

				• Harmonics and K - Factor transformer • Harmonics and K - Factor transformer **Ref 42**							
	5	1,4	3	Transient Voltage Surge Suppressor (TVSS) • TVSS Ratings • TVSS specification • The selection of surge suppressor • TVSS Selection Chart • Benefits of Transient Voltage Surge Suppressor Demonstrate different TVSS **Ref 42**	1		3	Uninterrupted Power Supply (UPS) System: • Typical Schematic diagram of Uninterruptible Power Supply • Loading versus. Efficiency Curve for a UPS • Comparison of the efficiency curves vs IT load for two different Data centers UPS Topologies • Offline UPS: (Passive standby) • Line interactive • Online double conversion • Selection criteria • UPS configuration • High availability power system **Ref 42** Demonstrate Modular/compact ups used in Data centres **Ref 42c**	2		**1**
	5	4	4	Determination of availability • MTBF (Mean time before failure) • MTTR (Mean Time between Repair) **Power Distribution Unit (PDU)** • Diagram of Power Distribution from the UPS to the IT load through the PDU	2		2	Advanced power strip • Benefits of Advanced Power Strips • Energy-saving opportunities in Electrical systems- • Demonstrate use of Advanced power strip **Ref 42**	1		2

				Modular Power Distribution Unit (PDU • Demonstrate Modular Power Distribution Unit (PDU) • An ideal power distribution system attributes: • Schematic of Modular Power Distribution System Static switch: • Static Transfer switches • Benefits of STS • Demonstrate working of STS (Static Transfer switches) **Ref 42**							
			5	**CIE 5 Written and practice test**	-	-		**Assessment Review and corrective action**			3
			6	**Industry Class + Assignment**	**2**		**3**				
12	5		1	**Peer discussion on Industrial assignment.**	-	4	-	Substation equipment needed to power up the data center: **Ref 42 a** **Cost of Data Centre Outages** **Ref 42 b**	2		1
	5	1,4	2	**Power quality** **Understanding the Importance of Power Quality in the Data Centre** • What is Power Quality • Need for power quality Power Quality Parameters • Reactive power and power factor • Total harmonic distortion (THD) Potential Impact of following parameters in the data center • Transients	1		3	Measure and analyse power quality parameters using a power analyser for the following • Induction motor on load • UPS supplying power to computers Remedial measures to mitigate power quality issues. **Ref 43** power quality meters **Ref 44a &b**			3

				• Interruptions • Sag / Under voltage • Swell / Over voltage • Waveform distortion • Voltage fluctuations • Frequency variations **Understanding the Importance of Power Quality in the Data Center** **Ref 45**							
	5	1,2	3	Medium-Voltage Circuit Breaker-Type Automatic Transfer Switches and Bypass/Isolation Switches Fail-Safe vs. Maintenance Bypass Switches: A Comparison **Ref 46** • Standard Critical Power Distribution Unit • Standard and Intelligent Critical CPDUs • Power Usage Effectiveness (PUE) **Ref 47** Recommended practice for electrical preventative maintenance **Ref 48**	1		2	Ways Data Centres Can Improve Energy Efficiency **Ref 49** Datacenter energy management **Ref 50** Best practices for energy management **Ref 51** Energy-efficient guidelines and best practices in energy management in Indian datacentres **Ref 52**	1		2
	5	2,4	4	**Case studies** Case study 1: Power quality improvement in a data centre by installing harmonic filters Case study 2 Energy efficiency improvement in lighting system by replacing			4	Water consumption in data centers **Ref 54** Estimating a data center's carbon footprint **Ref 55** Data centers in Bangalore **Ref 56**			3

				fluorescent lamps with light-emitting diode (LED) lamps Case study 3: Energy efficiency improvement in ups systems by loading optimization **Ref 42** Data center case study 4 **Ref 53**							
			5	**Developmental Assessment**	-	-		**Assessment Review and corrective action**			3
			6	**Industry Class + Assignment**	**2**		**3**				
Week	**CO**	**PO**	**Days**	**1st session (9am to 1 pm)**	**L**	**T**	**P**	**2ND session (1.30pm to 4.30pm)**	**L**	**T**	**P**
13	1,2, 3,4, 5	2,3, 4		**Internship** a) Secondary research on various industries and their operations to identify at least 3 companies along with the areas of work interest and develop an internship plan that clearly highlights expectations from the industry during the internship. b) Design and develop a cover letter for an internship request to all 3 identified companies and the resume to be submitted to potential companies. c) Prepare for an internship interview to highlight your interests, areas of study, career aspirations and personnel competence – including the areas of learning you expect to learn during internship	2	4	2	**Project** a) Identification of the problem statement (from at least 3 known problems) the students would like to work as part of the project – either as provided by faculty or as identified by the student. Document the impact the project will have from a technical, social and business perspective. b) Design and develop the project solution or methodology to be used to solve at least one of the problems identified. Prepare a project plan that will include a schedule, WBS, Budget and known risks along with strategies to mitigate them to ensure the project achieves the desired outcome.		4	10

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CIE and SEE Assessment Methodologies

CIE Assessment	Assessment Mode	Duration In hours	Max Marks
Week 3	CIE 1– Written and practice test	4	30
Week 5	CIE 2– Written and practice test	4	30
Week 7	CIE 3– Written and practice test	4	30
Week 9	CIE 4– Written and practice test	4	30
Week 11	CIE 5– Written and practice test	4	30
	On line Course work (Minimum 10 hours online course with certification from (SWAYAM/NPTEL/Infosys Springboard)		40
	Profile building for Internship / Submission of Synopsys for project work		20
Portfolio evaluation (Based on industrial assignments and weekly developmental assessment) *			30
TOTAL CIE MARKS (A)			**240**
SEE 1 - Theory exam (QP from BTE) Conducted for 100 marks 3 hrs duration reduced to 60 marks		**3**	**60**
SEE 2 – Practical		**3**	**100**
TOTAL SEE MARKS (B)			**160**
TOTAL MARKS (A+B)			**400**

* The industrial assignment shall be based on peer-to-peer assessment for a total of 10 marks (on a scale of 1 to 10) and in the event of a group assignment the marks awarded will be the same for the entire group, the developmental assessment will be for a total of 20 marks and based on MCQ/case study/demonstration and such other assignment methods

Assessment framework for CIE (1 to 5)

Note: Theory to be conducted for 1 hour and practice for 3 hours, total duration of exam – 4 hours

Programme	**Electrical & Electronics Engineering**	**Semester**		**V**	
Course	**Power Engineering**	**Max Marks**		**30**	
Course Code	**20EE52I**	**Duration**		**4 hours**	
Name of the course coordinator					
Note: Answer one full question from each section.					
Qn.No	**Question**	**CL L3/L4**	**CO**	**PO**	**Marks**
Section-1 (Theory) – 10 marks					
1.a)	Classify EV charging infrastructure with neat sketch.	L3	1	1	5
b)	What type of connectors you recommend for a 4 wheeler for AC charging/DC charging	L3		1	5
2.a)	Which IEC standard defines different modes for EV charging and explain those charging modes with a neat sketch.	L3		1	10
Section-2 (Practical) - 20 marks					
3)a.	Identify components of a charging station and demonstrate its working.	L3	1	2	10
b.	Identify different EV charging connectors	L3		2	5
c.	Select the suitable charger for a given vehicle type power rating and voltage	L3		2	5

Note : Theory questions shall be aligned to practical questions

Assessment framework for SEE 1 (Theory)

Programme	:	**Electrical & Electronics Engineering**			
Semester	:	**V**			
Course	:	**Power Engineering**	**Max Marks**	:	**100**
Course Code	:	**20EE52I**	**Duration**	:	**3 Hrs**

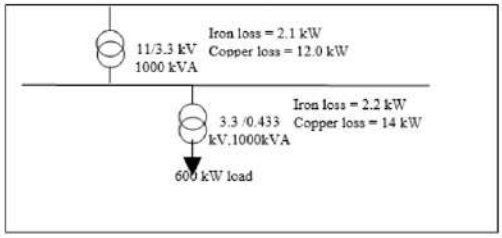
Instruction to the Candidate: Answer one full question from each section.

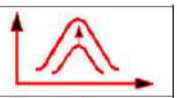
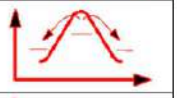
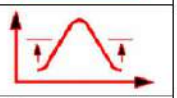
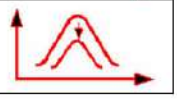
Q.No	Question	CL	CO	Marks
	Section-1			
1.a)	How will you apply design thinking process to install EV charging station in your institute?	L4	1	5
b)	Differentiate between level 1, Level 2 and Level 3 charging. Select suitable charging levels for Two wheelers and Four wheeler vehicle. Select type connectors for only DC charging.	L3		10
c)	What do you think are the main barrier holding the commercialization of high voltage high power wireless power transfer (WPT) for EV? Which IE standard covers wireless power transfer?	L3		5
2.a)	Which charging protocol you suggest which provides DC charging standards for EV that ensures seamless communication between charging point and vehicle and justify your suggestion.	L4		5
b)	Can you charge EV vehicle by wireless power transfer methods? Justify your answer with neat sketch.	L3		10
c)	What type of converters you suggest to be included in a DC charging station? Justify your answer with neat block diagram.	L3		5
	Section-2			
3.a)	A family based in Delhi is planning to purchase an electric four-wheeler with a battery capacity of 45 kWh. It is evaluating whether an EV metered connection is economical, considering that the alternative is to use the existing Domestic electricity connection. The family's average monthly electricity consumption from April to September is about 380 units and its sanctioned load has headroom to meet an additional load of about 3 kW. What is the most economic option for the family?	L3	2	10

Energy charges(₹/kWh) based on monthly consumption				
0-200 units	201-400 units	401-800 units	801-1200 units	>1200 units
3.00	4.50	6.50	7.00	8.00

<table>
<tr><td></td><td>A domestic household connection in Delhi attracts energy charges based on consumption slabs, as shown in the table above. Delhi's EV tariff has an energy charge of ` 4.50 per unit and no demand charge. For the family's requirement, the EV needs to be charged every five days, from 20% to 100% state of charge. The monthly electricity consumption from EV charging thus comes out to approximately 216 units</td><td></td><td></td><td></td></tr>
<tr><td>b)</td><td>Suggest any device is to detect the fault current EV charging station and how will you install such device in EV charging stations.</td><td>L3</td><td></td><td>10</td></tr>
<tr><td>4. a)</td><td>A CPO has identified a location for setting up a standalone charging facility and wants to install two 50 kW chargers, three 7 kW chargers, and a 9-unit stack battery charging system. After consulting the DISCOM, it is found that the nearby DT has available capacity to support an additional load of 48 kW, beyond which its capacity would need to be augmented. Moreover, the supply code stipulates 7 kW and 65 kW as the maximum sanctioned load limits for single-phase LT and three phase LT electricity connections respectively.</td><td></td><td></td><td>10</td></tr>
<tr><td>b)</td><td>What do think are the key challenges faced integrating EV charging infrastructure with the grid support your answer with sketches and graphs?</td><td>L3</td><td></td><td>10</td></tr>
<tr><td colspan="5">Section- 3</td></tr>
<tr><td>5. a)</td><td>Compute AT & C (Aggregate Technical and Commercial) Losses for the following data:
<table>
<tr><th>S. No.</th><th>Description</th><th>Annual Data</th></tr>
<tr><td>1</td><td>Input Energy = (Import-Export), MU</td><td>11</td></tr>
<tr><td>2a</td><td>Energy Billed (Metered), MU</td><td>7</td></tr>
<tr><td>2b</td><td>Energy Billed (Un-Metered), MU</td><td>1</td></tr>
<tr><td>2c</td><td>Total Energy Billed</td><td>8</td></tr>
<tr><td>3</td><td>Amount Billed (Rs. lakhs)</td><td>450</td></tr>
<tr><td>4a</td><td>Gross Amount Collected (Rs. lakhs)</td><td>460</td></tr>
<tr><td>4b</td><td>Arrears Collected (Rs. lakhs)</td><td>40</td></tr>
</table></td><td>L3</td><td rowspan="5">3</td><td>5</td></tr>
<tr><td>b)</td><td>Is Time of Day (TOD) Tariff is beneficial for Utility
And consumers? Justify your Answer.</td><td>L3</td><td>7</td></tr>
<tr><td>c)</td><td>What is IED? Can it perform the role of protective relay? Justify your answer. Name any one communication protocol it supports.</td><td>L3</td><td>8</td></tr>
<tr><td>6. a)</td><td>Compare smart grid with conventional utility grid.</td><td>L3</td><td>5</td></tr>
<tr><td>b)</td><td>Case:
The CESC, Mysore Smart grid pilot Project involves 21,824 consumers with a good mix of residential, Commercial, industrial and agricultural consumers including 512 irrigation pump sets covering over 14 feeders and 473 distribution transformers and accounting for input energy of 151.89 MU. Additional functionality like Agriculture DSM with community portal, consumer portal to support DSM/DR,</td><td>L4</td><td>10</td></tr>
</table>

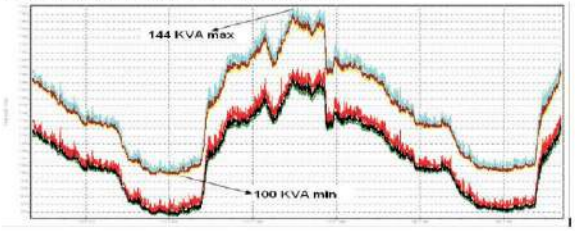
	employee portal for knowledge sharing and benefit realization, KPI based MIS and data analytics for decision support are also proposed. 19600 Single Phase meters, 548 three phase smart metrs, 453 DCUs, 318 DTMU, 5 FPIs and 130 HT modems installed. 16000 meters and 80 modems are communicating with Head End System. 500 RF pre-payment meters delivered. 494 installed and 300 of them commissioned. 200 RF Net meters delivered, 1 meter installed. 53 LT-CT meters installed. 1. What do you understand from the term "Agriculture DSM ". 2. What would be the likely benefits and outcomes from this Smart grid pilot project.			
c)	Case study: MERC introduced reliability surcharge for withdrawal of load shedding. During 2006-07, in order avoid Load shedding in Pune City, the stranded/ surplus Captive Power Plant Capacity in and around Pune (about 90 MW) was used to mitigate the Load shedding. During the Load shedding hours, these Captive Plants (costly power) were put "ON" and load shedding in Pune city was avoided transforming Pune as the "Zero load Shedding" City. The charges for Captive Power (Costly power), used to mitigate the Load shedding, were being charged to all consumers in Pune city. The Domestic Consumers with consumption less than 300 Units/ month Were excluded from charging the Surcharge. All other Consumers in Pune City were levied Reliability Charge of Rs. 0.42 per Unit, which was in lieu of providing reliable supply to consumers (Zero Load shedding) What conclusions can you draw from the above case study	L4		5
	Section-4			
7.a)	An energy manager or energy auditor is trying to establish the power factor of a 15 HP induction motor. The instrument to measure electric parameters displays the three numbers 5 kW and 2 kVAr and PF = 92.8%. Do you fully agree with the instrument display and its correctness? **OR** Energy auditor is invited by an old textile mill to identify the scope of electricity savings in the distribution system. After, a visit to the mill substation, the auditor observes the following voltage distribution arrangement. In your view, what best option he would like to suggest to the management for its detail investigation. (Note: The detail technical and financial implications at this stage are not to be considered. Only concept to be mentioned)	L4	4	5

				
b)	Suggest new method to ESCOMS to reduce distribution losses in your area. Perform cost benefit analysis for the project.	L3		10
c)	What is motor load survey? Suggest Energy Conservation Measures for the following 35 to 50% Load variation > 50- 60% Loading	L3		5
8.a)	A 15 kW rated motor burns out. The financial manager of the firm wants to rewind the motor for Rs.3000 to save money. The Energy Manager wants to buy a new premium motor for Rs.20,000/- after selling motor for Rs. 5,000. He claims that he can save much more money in the next five years than the cost difference of the above two options. Other data is as under: Operating hours/year = 8000 Rewound motor efficiency = 89% New premium motor efficiency = 93% Motor loading = 75% Power cost = Rs.4/kWh (i) How much money does the energy manager actually save over 5 years and what is the simple payback period?	L3		10

	(ii) The financial manager claims the financial risk is still too high because operating hours may go down drastically in the next years. How many operating hours/year are required to recover the cost difference within 5 years.			
b)	An energy auditor works out the percentage loading of a particular induction motor as a ratio of current drawn to the rated current of the motor. a) Do you agree with the above methodology adopted by the consultant? Justify your answer with reasons. b) In your opinion what is the right approach for working out the motor loading?	L3		5
c)	Match the following load-shape objectives of any Demand Side Management (DSM) programme of a utility. i Peak Clipping a  ii Valley filling b  iii Load shifting c  iv Conservation d  v Load building e 	L3		5
	Section-5			
9.a)	Case : The company is an Indian telecom giant with an exclusive Datacentre catering to their internal needs. The organization conducted an energy study to look into opportunity-related cost reduction through	L4		10

	Better energy management. The measured system power factor was 0.88 lagging for the average load of 1030 kW. The harmonic levels in the system were also measured with a power quality analyser. Answer the following questions. 1. How will you improve the factor to 0.97? 2. What are causes for poor power factor? 3. Why harmonics are generated in Datacentre. 4. How will you solve harmonics problem. 5. What are likely benefits of improving power factor and minimising harmonics?			
b)	What do you think are the key factors affects the carbon footprint of a datacentre, justify the answer with facts and figures.	L3		10
10.a)	Case: • The organization is a well-known software development company with international clientele. The • Organization maintains a Datacentre which caters to the needs of various clients abroad. The company initiated various programmes for energy management and also conducted Power Quality and Energy audit. • During the assessment of the UPS, the loading on the UPS system was found to be changing constantly. • The change in loading pattern was due to • Flexible operating hours of developers resulting in randomness of load • A number of software development projects being worked upon • For a maximum load of 200 kVA, four modules of 200 kVA UPS were installed in a 4 x 200 KVA configuration as shown in figure 2.27. Thus, even if the load equals 200 kVA, each UPS would be loaded to a maximum of 25% only. In reality, the load was never 200 kVA but lower, varying from a minimum of 100 kVA to a maximum of 144 kVA at different times of a day, thus imposing loads of differing percentages on the UPS systems. The loading pattern observed for	L4	5	10

the period of two days is shown in figure



%Loading	Efficiency
10%	80.00%
15%	84.00%
20%	87.00%
25%	89.16%
30%	91.00%
40%	91.95%
50%	92.80%
60%	93.00%
70%	93.40%
80%	93.46%
90%	93.15%
100%	93.00%

EFFICIENCY DATA OF 200 KVA UPS SYSTEM

Answer the following questions.

1. What is the UPS efficiency when the load varies from 100KVA to 144 KVA?
2. How will you improve the UPS efficiency?

	3. Suppose the efficiency of the UPS system was improved by 6.7%. What is likely reduction of demand consumption? 4. What is the financial implication of your solution?			
b)	Suggest the substation equipment needed to power up the data centre, justify your answer with neat block diagram.	L3		10

Scheme of Evaluation for SEE 2

Sl. No	Description	Marks
1	Identify charging level , plugs , sockets and connector and associated charging protocols as per given requirements	10
2	Install, Commissioning and testing of EV station	30
3	Simulation exercise on EV/SCADA/smart grid/IOT **OR** Automate given system using IOT **OR** Install and Test smart energy meter	30
4	Measure and analyse power quality parameters using a power analyser for the any given load. Suggest remedial measures to mitigate power quality issues.	20
5	Energy audit report	05
6	Demonstrate the use of the energy audit instruments.	05
	Total	**100**

Equipment/Software list with Specification for a batch of 20 students

Sl. No.	Description of the equipment/ Hardware/ Software	Specification	Total Quantity Required (A)
1	Charging Station	Bharat AC-001, 3.3 kW Output Power	1
2	Charging Station	Bharat DC-001, 15 kW Output Power	1
3	Charging Station	Type 2 AC , 22 kW Output Power	1
4	Arduino Board		10
5	Raspberry Pl		5
6	Smart Energy Meter	1ph and 3ph, LCD with pulse output	2
7	Digital Lux Meter		2
8	Infrared Thermometer		2
9	TDS meter		2
10	Power Quality analyser		2
11	SCADA lab kit	PUSPAC-RTU with field simulation bench IEC 60870-5-104 compliant Master/RTU simulator IEC 60870-5-101 - IEC 60870-5-104 protocol converter User friendly web based GUI Historical database management Flexible reporting system and trending Customized tag configuration Alarm/Event handling Can connect to IEC 60870-5-104 compliant RTU Can connect to IEC 60870-5-101 compliant RTU using "SMART ProGate"	1