REF. NO. : EX/PE/PE/H/T/324C/2024

NAME OF THE EXAMINATION: **B.E. POWER ENGINEERING THIRD YEAR SECOND SEMESTER - 2024**

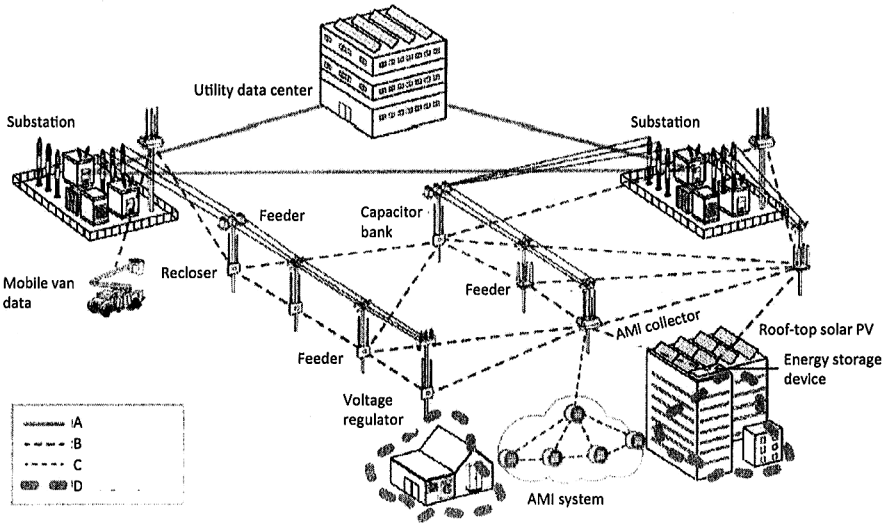
SUBJECT: **SMART GRID SYSTEMS (HONS.)**

TIME: 3 HOURS **FULL MARKS: 100**

CO1: Describe the concepts of smart grid system and differentiate its various components (K2)
CO2: Explain the control, communication and data monitoring topologies of smart grid system (K5)
CO3: Analyze and explain different socio-techno-economic aspects of smart grid systems (K4, K5)
CO4: Investigate the integration process of various renewable energy sources and energy storage systems with smart grid (K2, K5)

Attempt All Questions

Q1.	***Choose the correct option for any twenty (20) of the following*** ***[20@1 = 20]***	
(i)	The most essential component of a smart grid is ..... (a) Storage cell (b) communication (c) Electric vehicle (d) Renewable energy	[CO1]
(ii)	Which of the following is (are) not a (the) key driver(s) of Smart Grids? (a) Timely completion of projects (b) Peak load management (c) Reduction of T&D losses in all utilities as well as improved collection efficiency (d) Financially sound utilities	[CO1]
(iii)	Smart Grid Technology comprises of the following: (a) AMI, PLM, AVR, LFC, Renewable Integration, Micro grid (b) DR/DSM, Distribution Automation, Energy Efficient Systems (c) All of (a) and (b) (d) Only (a), but not (b)	[CO1]
(iv)	Sensors are generally NOT used for the following purposes in Smart Grids (a) Power line communication (b) Real time sensing of mechanical and electrical conditions of power line (c) Detect mechanical failures, tower collapses, extreme mechanical conditions (d) Diagnose imminent as well as permanent faults	[CO1]
(v)	A smart grid is _____ whereas conventional grids are _____ (a) constant, variable (b) sequential, unidirectional (c) adaptive, predictive (d) networked, radial	[CO1]
(vi)	In smart grid transmission domain, which one of the following is NOT an important task of the system operator to ensure optimal utilization of the transmission network: (a) minimizing the ATC losses (b) minimizing the voltage deviations (c) reducing conductor size (d) maximizing reliability	[CO1]
(vii)	What are the main goals of Automatic Generation Control (AGC) in smart grid? A. keep overshoot and settling time of the governor within the acceptable ranges B. curtail load so as to match supply with demand C. keep the voltage and frequency of supply within specified tolerance band	[CO2]

	D. keep the operating frequency under prescribed limits E. maintain the interchange power between grids through tie-lines at the intended level The correct combination is (a) A, C, D, E (b) A, D, E (c) A, B, C (d) B, C, D	
(viii)	Full form of TCR as applied in FACTS devices for Automatic Voltage Regulation in smart grid is: (a) Thyristor-controlled-reactor (b) Thyristorized-controlling-resistance (c) Transmission-curtailing-reactor (d) Thyristor-capacitor-reactor	[CO2]
(ix)	Attributes of SCADA for Distribution Management System (DMS) in smart grid are: A. Meter reading and bill generation B. Data storage, event log, analysis and reporting C. Data acquisition D. Monitoring, event processing and alarms E. Control The correct combination is (a) A, C, D, E (b) B, C, D, E (c) A, B, D, E (d) A, B, C, D	[CO2]
(x)	Identify the communication protocols used in Outage Management System (OMS) in smart grid:  The correct order of A, B, C, D communication protocol is (a) Core IP Network, FAN, NAN, HAN (b) WAN, NAN, FAN, HAN (c) Core IP Network, WAN, FAN, HAN (d) Core IP Network, WAN, NAN, HAN	[CO2]
(xi)	Some functions of MDM are: A. Direct load connect/disconnect B. Demand Control/Demand Response Support C. Reporting D. Billing Calculations E. Alarm Generation F. Smart meter firmware update G. Data Validation, Estimation, and Editing (VEE)	[CO2]

	The correct combination is (a) B, C, D, E, G (b) A, C, E, F, G (c) B, C, D, E, F (d) A, B, D, F, G	
(xii)	Mobile Workforce Management (MWM) in smart grid is a part of: (a) Automatic generation control (AGC) (b) Demand response management (DRM) (c) Outage management system (OMS) (d) Supervisory control and data acquisition (SCADA)	[CO2]
(xiii)	A sustainable energy solution feature of smart grid implies that the operation must be (a) Economic (b) Environmentally benign (c) Socially acceptable (d) All of the above	[CO3]
(xiv)	If you are the CEO of CESC, what up gradations you should plan in you power distribution infrastructure so that the CESC grid becomes compatible to large scale deployment of plug-in electric vehicles (PEVs) among your consumers? A. Managing the load balancing, peak hour shaving, off-peak charging, tariff structure and economic and cost effective user billing infrastructure B. Manufacture energy efficient batteries C. Upgrade to smart grid so that PEV batteries in V2G mode can be used as distributed storage during excess RES generation hours D. Manage PEV charging facilities so that the grid is not over-burdened due to rush-hour charging E. Upgrade to smart grid so that PEV batteries G2V mode can be used as distributed generation sources during peak-load periods thereby reducing burden on conventional generating plants The correct combination is (a) A, B, C, E (b) A, C, D, E (c) A, B, C, D (d) B, C, D, E	[CO3]
(xv)	Advantages of Decentralized EMS over Centralized EMS are: A. Higher flexibility B. Lower computational burden C. Faster response time D. The redundancy of controllers and communication contribute higher reliability E. Decentralized EMS provides global optimization hence provides a reduction in total operating cost The correct combination is (a) A, B, C, D (b) B, C, D, E (c) A, C, D, E (d) A, B, C, E	[CO3]
(xvi)	Demand side management (DSM) in smart grid can be defined as a set of techniques that can be used to _____ pattern of the end users of electricity over time (a) curtail the energy usage (b) minimize the energy consumption (c) modify the consumption (d) reduce the ATC loss	[CO3]

(xvii)	The main components of Wide Area Monitoring System (WAMS) in Smart Grid are: A. Data storage B. Communication networks C. Application software D. FACTS Devices E. Phasor Data Concentrators (PDCs) F. Phasor Measurement Units (PMUs) G. Smart Energy meter H. Programmable Logic Controller (PLC) The correct combination is (a) C, D, E, F, H (b) B, C, D, F, H (c) A, B, C, E, F (d) A, C, F, G, H	[CO3]
(xviii)	Utilities make use of the following smart grid installations to improve outage management system (OMS) response: (a) AMI, FCI, DA (b) AMI, AVR, DMS (c) DA, DSM, DR (d) AVR, FCI, DMS	[CO3]
(xix)	To operate and manage RE generation into the grid, separate centers developed are: (a) Regional Load Dispatch Centre (b) State Load Dispatch Centre (c) Renewable Energy Management Centre (d) All of the above	[CO4]
(xx)	What are the challenges in RE integration to smart grid? (a) Variability & intermittency (b) Highly cost (c) High unpredictability (d) Both options (a) and (c) (e) All of the options (a), (b), and (c)	[CO4]
(xxi)	Most RE sources like wind and solar energy cannot be directly connected to the grid because (a) RES generation locations are much further away from the main grid (b) RES generation quality and quality most often does not match grid codes (c) RES generation quality and quantity are much lower than the grid capacity (d) RES are unpredictable	[CO4]
(xxii)	RES integration to grid introduces harmonics in the power system due to (a) presence of power electronic converters (b) improper forecasting of solar and wind availability data (c) mismatch between RES generation and load demand (d) uncontrolled variability of the primary sources	[CO4]
(xxiii)	Some of the requirements of ESS for making it grid-compatible are: A. Reliability B. High energy density C. Water-proof D. Long life-cycle E. Cost-effectiveness F. Light-weight G. Large capacity H. Environmentally less harmful The correct combination is	[CO4]

	(e) A, B, D, E, F, H (f) A, C, D, E, G, H (g) A, C, D, F, G, H (h) A, B, D, F, G, H	
(xxiv)	Incorporation of distributed energy storage can benefit the smart grid in the following ways: A. Fault diagnosis B. Power quality improvement C. Wide area monitoring D. Investment deferral E. RES integration F. Optimization and grid balancing G. Grid operation The correct combination is (e) B, D, E, F, G (f) A, C, D, E, F (g) B, C, E, F, G (h) A, B, D, E, F	[CO4]

Q2. Answer any two (2) questions	***[2@10 = 20]***	*[CO1]*
(a)	(i). Define "Smart Grid" as per IEEE mentioning the various layers of it as per IEEE. (ii). Compare between conventional power grid and smart grid with respect to the following characteristics: Architecture, Generation and storage options, Disaster management, Communication	2 + 8
(b)	(i). List the advantages of Smart Grid over conventional power grid. (ii). Explain the significant challenges faced while deploying smart grid infrastructure by upgrading the existing power grid.	3 + 7
(c)	(i). What are the various domains of smart grid? Pictorially describe how these domains are interrelated with each other. (ii). What are the roles and responsibilities of "Operations domain" in smart grid infrastructure?	5 + 5

Q3. Answer any two (2) questions	***[2@10 = 20]***	*[CO2]*
(a)	(i). What are the main goals of Automatic Generation Control (AGC) system? Why it is also called LFC system? (ii). (ii) What new challenges are faced by AVRs in power network that has high penetration of RES and PEVs? How are these challenges addressed in a smart grid infrastructure?	4 + 6
(b)	(i). Define Wide Area Monitoring System (WAMS) as applied to Smart Grid (ii). What is SCADA? List its components and describe their functions using schematic diagram.	2 + 8
(c)	(i). List the components of a smart energy meter. Draw its internal architecture. How is it different from a conventional energy meter? (ii). What are the different components of a Meter Data Management (MDM) system in smart grid? Draw a schematic diagram to show the interconnection between these components.	5 + 5

	Q4. Answer any two (2) questions ***[2@10 = 20]***	*[CO3]*
(a)	(i). State the advantages of implementing Outage Management system (OMS) in smart grid. List the steps through which an OMS works. (ii). What is the need for Distribution Management system (DMS) in modern smart power grid? What are the goals of a DMS?	5 + 5
(b)	(i). Define Demand Side Management (DSM) as applied to Smart Grid technology? How is DSM beneficial to the utility as well as to the consumer? (ii). Define Demand Response Management (DRM) is Smart Grid Technology. With a suitable schematic diagram, discuss the different communication standards employed for implementing DRM.	5 + 5
(c)	(i). Define Energy Management System (EMS) in the context of Smart Grids. What are the main functions of an EMS in smart grid? (ii). List the components of EMS with the help of a block diagram	5 + 5

	Q5. Answer any two (2) questions ***[2@10 = 20]***	*[CO4]*
(a)	(i). Highlight the benefits of integration of renewable energy sources in the power network (ii). Describe any two technical challenges involved in integration of renewable energy sources to grid and point out the ways of addressing those challenges	4 + 6
(b)	(i). List the benefits of energy storage in smart grid. (ii). What are the components of a typical Battery Management System (BMS) as a component of smart grid? Explain with a suitable diagram.	4 + 6
(c)	(i). With a neat schematic diagram, show the internal components of a plugged-in Electric Vehicle (PEV). (ii). What are the technical challenges for large scale adoption of PEV?	4 + 6