Roll No.											

PRESIDENCY UNIVERSITY

BENGALURU

End - Term Examinations – MAY /JUNE 2026

Date: 22-05-2026 **Time:**01:00pm – 04:00pm

School: SOE	**Program:** EEE	
Course Code: EEE3025	**Course Name:** Power System Operation and Control	
Semester: VI	**Max Marks**:100	**Weightage**: 50%

CO - Levels	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
Marks	**24**	**24**	**14**	**14**	**12**	**12**

Instructions:

(i) Read all questions carefully and answer accordingly.
(ii) Do not write anything on the question paper other than roll number.

Part A

Answer ALL the Questions. Each question carries 2marks. **10Q x 2M=20M**

1.	Maximum demands of three feeders are 40 kW, 50 kW, and 60 kW. Maximum demand of the substation is 120 kW. Find the diversity factor.	**2 Marks**	**L3**	**CO1**
2.	Explain the terms average load and peak load of a power system.	**2 Marks**	**L2**	**CO1**
3.	An interconnected power system has an equivalent speed regulation of Req= 5 Hz/pu MW. If a load increase of 0.15 pu occurs, determine the steady-state frequency deviation.	**2 Marks**	**L3**	**CO2**
4.	Explain the concept of Area Control Error.	**2 Marks**	**L2**	**CO2**
5.	Explain the term synchronizing power coefficient in tie-line power flow.	**2 Marks**	**L2**	**CO3**
6.	Explain the concept of Load Frequency Control (LFC) in an interconnected power system.	**2 Marks**	**L2**	**CO3**

7.	If the tie-line synchronizing coefficient is 0.1 and the frequency difference between two areas is 0.02 Hz, determine the approximate tie-line power deviation.	**2 Marks**	**L3**	**CO4**
8.	Explain the role of coherent generators in forming a control area for AGC.	**2 Marks**	**L2**	**CO4**
9.	Explain the role of an IED in a SCADA system.	**2 Marks**	**L2**	**CO5-CO6**
10.	Explain the challenges associated with data acquisition in power system networks.	**2 Marks**	**L2**	**CO5-CO6**

Part B

Answer the Questions. **Total Marks 80M**

11.	**a.**	Explain the Operating States of a Power System and illustrate them with a suitable diagram.	**10 Marks**	**L2**	**CO1**
		Or			
12.	**a.**	A thermal power station operates two generating units in parallel to supply a total load demand of 180 MW. The system operator aims to achieve economic operation by minimizing the total fuel cost. Since the transmission network is short, transmission losses are neglected for simplicity. Two generating units supply a load of 180 MW. Transmission losses are neglected. The cost functions of the generating units are given as: $$C_1 = 450 + 6P_{G1} + 0.03P_{G1}^2$$ $$C_2 = 350 + 7P_{G2} + 0.05P_{G2}^2$$ Determine optimal generation and incremental cost.	**10 Marks**	**L3**	**CO1**

13.	**a.**	Explain the difference between Unit Commitment and Economic Load Dispatch.	**10 Marks**	**L2**	**CO1**
		Or			
14.	**a.**	Determine the priority list for the generating units given below based on their fuel cost characteristics. Unit 1: $$F_1 = (7 + 0.003P_1) \times 10^3 \text{ kcal/MWh}$$ Operating limits: $$P_1^{\min} = 50 \text{ MW}, P_1^{\max} = 500 \text{ MW}$$ Unit 2: $$F_2 = (7.5 + 0.002P_2) \times 10^3 \text{ kcal/MWh}$$	**10 Marks**	**L3**	**CO1**

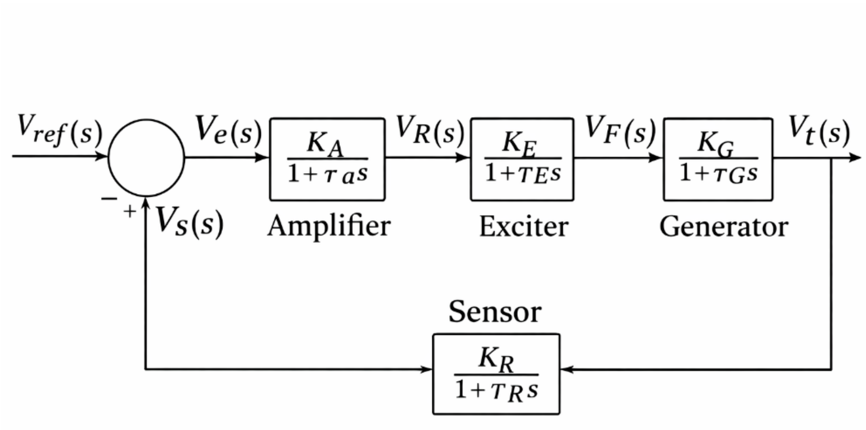
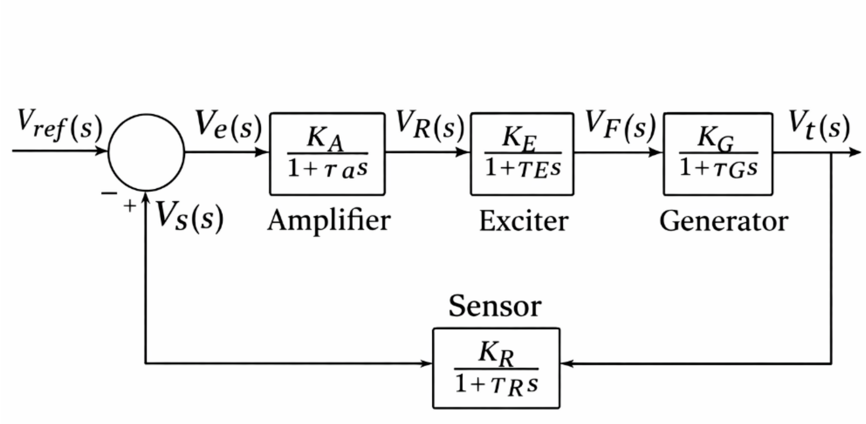
		Operating limits: $$P_2^{\min} = 40 \text{ MW}, P_2^{\max} = 400 \text{ MW}$$ Unit 3: $$F_3 = (8 + 0.004P_3) \times 10^3 \text{ kcal/MWh}$$ Operating limits: $$P_3^{\min} = 20 \text{ MW}, P_3^{\max} = 200 \text{ MW}$$ The fuel cost coefficients are: $$C_{P1} = 1.1 \text{ Rs/kcal}, C_{P2} = 1.05 \text{ Rs/kcal}, C_{P3} = 1.2 \text{ Rs/kcal}$$			

15.	**a.**	Illustrate the concept of Fly-Ball Speed Governors System for LFC.	**10 Marks**	**L2**	**CO2**
Or					
16.	**a.**	Two synchronous generators operate in parallel to supply a load of 400 MW. The capacities of the two machines are 200 MW and 500 MW. Each has droop characteristics of 4 %. Their governors are adjusted so that the frequency is 100 % on full load. Calculate the load supplied by each unit and frequency at this load. The system frequency is 50 Hz.	**10 Marks**	**L3**	**CO2**

17.	**a.**	Illustrate the need for Load Frequency and Excitation Control of Turbo Generator.	**10 Marks**	**L2**	**CO2**
Or					
18.	**a.**	An isolated power station has the following parameters: Turbine time constant $T_T = 0.5$sec Governor time constant $T_g = 0.2$sec Generator inertia constant $H = 5$sec Governor speed regulation Rper unit Load damping constant $D = 0.8$ Additional data: Governor speed regulation is set to $R = 0.05$p.u. Turbine rated output = 250 MW at 60 Hz Sudden load change $\Delta P_L = 50\text{MW} = 0.2$ p.u. The open-loop transfer function is: $$KG(s)H(s) = \frac{K}{(10s + 0.8)(1 + 0.2s)(1 + 0.5s)}$$ where $K = \frac{1}{R}$ Determine the range of R for which system become stable.	**10 Marks**	**L3**	**CO2**

19.	**a.**	Explain how a change in load in one area affects the frequency and tie-line power flow in another area of a two-area power system. Use a suitable diagram and relevant equations.	**10 Marks**	**L2**	**CO3**
Or					

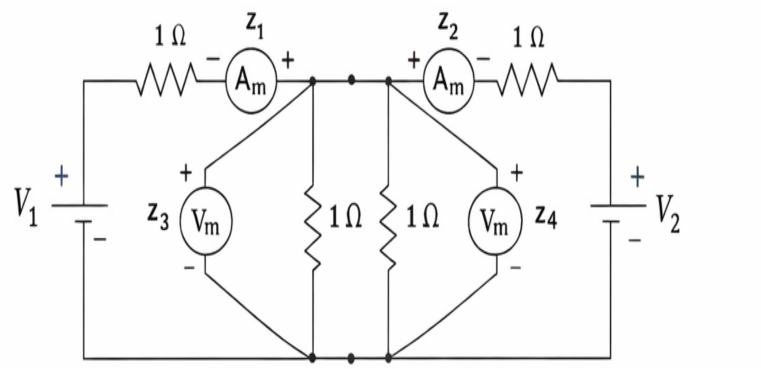
<table>
<tr><td>20.</td><td>a.</td><td>A two-area system connected by a tie-line has following parameters on 1000 MVA base;
$R_1 = 4.5\%;\ D_1 = 0.6;\ H_1 = 4.5;$
$R_2 = 6\%;\ D_2 = 0.85;\ H_2 = 5.0;$
The unites are running in parallel frequency of 50 Hz. The synchronizing power coefficient is 1.9 pu. at the initial operating angle. A load change of 150 MW occurs in area 1. Determine the new steady state frequency and the change in tie-line power flow.</td><td>10 Marks</td><td>L3</td><td>CO3</td></tr>
</table>

<table>
<tr><td>21.</td><td>a.</td><td>Explain the steady state response of the AVR for a step input reference. Where $\boldsymbol{T_A}, \boldsymbol{T_E}, \boldsymbol{T_G}$, and $\boldsymbol{T_R}$are the time constants of the different subsystem.

</td><td>10 Marks</td><td>L2</td><td>CO4</td></tr>
<tr><td colspan="6">Or</td></tr>
<tr><td>22.</td><td>a.</td><td>

Consider an Automatic Voltage Regulator (AVR) control system with the following parameters:
Amplifier:
Gain K_A ,time constant $T_A = 0.1$
Exciter:
Gain $K_E = 1$,time constant $T_E = 0.4$
Generator:
Gain $K_G = 1$,time constant $T_G = 1.0$
Sensor:
Gain $K_R = 1$,time constant $T_R = 0.05$</td><td>10 Marks</td><td>L2</td><td>CO4</td></tr>
</table>

		i) For the given data construct the block diagram of the AVR system. ii) For $K_A = 10$ find the final value of $V_t(\infty) = \lim_{s \to 0} sT(s)R(s)$. Where $R(s) = \frac{1}{s}$			

23.	**a.**	Explain the Significance of state estimation in context of Wide area management system.	**5 Marks**	**L2**	**CO5**
	b.	A power system operator is monitoring a transmission network using Phasor Measurement Units (PMUs). During system disturbances, accurate estimation of voltage magnitude, phase angle, and frequency is required in real time. However, the measured signals are time-domain sinusoidal waveforms affected by noise and harmonics. To extract synchronized phasor information, the PMU uses a Discrete Fourier Transform (DFT)-based algorithm. Based on the above scenario, explain the application of the Discrete Fourier Transform (DFT) algorithm in PMU operation.	**5 Marks**	**L2**	**CO5**
		Or			
24.	**a.**	A modern power grid is experiencing frequent disturbances due to sudden load variations and integration of renewable energy sources. The control center requires accurate and time-synchronized measurements from different substations to monitor system conditions and take corrective actions in real time. To achieve this, Phasor Measurement Units (PMUs) are installed at various locations in the network. Based on the above scenario, illustrate the working of a Phasor Measurement Unit (PMU) with a neat diagram.	**10 Marks**	**L2**	**CO5**

25.	**a.**	In a power system monitoring setup, multiple sensors are installed at a substation to measure current and voltage values. Due to noise and measurement inaccuracies, the readings obtained are slightly deviated from their true values. To improve accuracy, a weighted error analysis is performed as part of the state estimation process. The meter readings are $\boldsymbol{Z_1}$= 9.15A, $\boldsymbol{Z_2}$=2.93 A, $\boldsymbol{Z_3}$=6.90 V, and $\boldsymbol{Z_4}$=5.08 V. Weights are: $\boldsymbol{w_1} = \boldsymbol{w_2} = \mathbf{80}$, and $\boldsymbol{w_3} = \boldsymbol{w_4} = \mathbf{60}$. Calculate the G=$\boldsymbol{H^T}$WH. 	**10 Marks**	**L3**	**CO5-CO6**
		Or			
26.	**a.**	A large power utility operates multiple substations across a wide geographical area using a SCADA system for monitoring and control. Recently, during a fault condition, the system	**10 Marks**	**L4**	**CO5-CO6**

		experienced delays in data acquisition and response, leading to slower fault isolation and affecting system reliability. The utility management suspects that certain components of the SCADA system are causing inefficiencies in real-time operation. Based on the above scenario, analyze the operation of a SCADA system with a neat block diagram. Identify the role of each component (such as RTU, communication system, and control center).			