Kafrelsheikh University - Faculty of Engineering
Electrical Engineering Department
Course Code: EPM 4123
4th Year Electrical Power Students

Final Exam: Advanced control systems for electric power
Time Allowed: 3 hours
Full mark: 90
Date: 11 - 03 - 2021

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This exam measures the ILOs: a.4, a.5, b.2, b.3, b.5, c.2, c.4

Answer the following THREE questions: In each question, draw the circuit diagram and necessary waveforms and write the necessary equations to clarify your answer

First question: (30 Marks):

(a) Explain the alternative implementations of current droop (slope) in the voltage regulator of SVC. Using simplistic way of design, find the PI controller parameters of SVC voltage regulator. (10 Marks)

(b) The AVR system of a generator has the following parameters

	Gain	Time constant
Amplifier	K_A	$\tau_A = 0.2$
Exciter	$K_E = 1$	$\tau_E = 1$
Generator	$K_G = 1$	$\tau_G = 2.0$
Sensor	$K_R = 1$	$\tau_E = 0.08$

i- Use Routh-Hurwitz array to find the range of K_A for control system stability

ii- Propose ONLY ONE technique to improve the excitation system stability. (20 Marks)

Second question: (30 Marks):

(a) Discuss the SVC operation to regulate the common coupling point voltage depending on Composite SVC - power system characteristics. (10 Marks)

(b) A two-area system connected by a tie line has the following parameters on a 1000-MVA common base

Area	1	2
Speed regulation	$R_1 = 0.06$	$R_2 = 0.07$
Frequency load coefficient	$D_1 = 0.7$	$D_2 = 1$
Inertia constant	$H_1 = 5$	$H_2 = 4$
Base power	1000	1000
Generator time constant	$\tau_{g1} = 0.15$ s	$\tau_{g2} = 0.2$ s
Turbine time constant	$\tau_{T1} = 0.4$ s	$\tau_{T2} = 0.5$ s

The units are operating in parallel at the nominal frequency of 60 Hz. The synchronizing power coefficient is computed from initial operating condition and is given to be $P_s = 2.0$ per unit. A load change of 187.5 MW occurs in area 1. Determine the new steady-state frequency and the change in the tie-lone flow. (20 Marks)

Third question: (30 Marks):

(a) Explain the main components of the functional block diagram of the Phase Measurement Unit PMU installed in wide area control of power system. (10 Marks)

(b) Design simple block diagram of STATCOM controller to control both active and reactive power transfer between the main grid and the STATCOM internal storage system. (10 Marks)

(c) Discuss the communication topologies used in SCADA system and the advantage and disadvantages of each topology. (10 Marks)

With best regards