MEC(Elect)(PEPS), Sem-II, 27/4/15 27/4/15
Flexible AC Transmission

'Bharatiya Vidya Bhavan's
SARDAR PATEL COLLEGE OF ENGINEERING
(An Autonomous Institution Affiliated to University of Mumbai)
END SEMESTER EXAMINATION

Class: M.E. (Electrical) **Branch: Power Electronics and Power System**

Subject: FACTS (EE651) **Duration: 4 Hrs.**

SEM: II Flexible AC Transmission **Marks: 100**

Note : (1) Question No. 1 is **compulsory**
(2) Attempt **any four** questions from remaining five questions

Master File

Q.1

a) A three phase, 400 kV, 50 Hz, 900 km long line is operating with $V_s = V_R = V = 1.0$ pu and $\delta = 60^0$. A SVC is planned to be connected at the midpoint of the line to increase power transfer capability. The limits on the control range correspond to $\delta = 30^0$ and $\delta = 90^0$. Find the limits of SVC susceptance if the slope (Xs) of the control characteristic is **10**
 (i) 0.0 p.u.
 (ii) 0.05 p.u.

b) Describe the principle of operation of SVC with its control characteristics. **10**

Q.2

a) What are basic types of FACTS controller? Explain in short. **10**

b) Describe the principle of operation of a static phase shifting transformer **10**

Q.3

a) Describe the principle of operation of a TCSC, clearly indicating the different modes of operation and its analysis. **10**

b) With the help of a block diagram explain the basic UPFC control scheme. Discuss on the functional control modes of UPFC. **10**

Q.4

a) What are the power quality problems in distribution Systems? Explain in detail. **10**

b) Write short note on series and parallel resonances for harmonic condition **10**

Q.5

a) Write short note on 1) Passive filter **10**
 2) Active filter
 3) Voltage sags and swells

b) Explain in detail IEEE standards on power quality problems **10**

Q.6

a) How to mitigate power quality problems using power electronic conditioners? **10**

b) Give a detailed account on the working of a STATCOM. Discuss the advantages of using multi level converters in a STATCOM. **10**

MEC(Elect/PEPS), Sem-II, Advanced Control of Electrical Drives.

Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

(An Autonomous Institution Affiliated to University of Mumbai)

First Half 2015
End Sem. Examination

Total Marks: **100** Duration: **3 Hours**

Class/Sem: **M.Tech. (PEPS) / Sem II** Sub: Advanced Control of Electrical Drives

- Attempt any **FIVE** question out of **SEVEN** questions
- Answers to all sub questions should be grouped together
- Figures to the right indicate full marks
- **Assume suitable data if necessary and justify the same.**

master

Q.1a) Derive the state space model of separately excited DC motor. **(10)**

b) What is the effect of variation in switching frequency of dc-dc converter on the operation of dc motor. **(04)**

c) A 230 V, 960 rpm and 200A separately excited DC motor has an armature resistance of 0.02 Ω, The motor is fed from a chopper which provides both motoring and breaking operation. The source has a voltage of 230 V. Assuming continuous conduction. **(06)**

(i) Calculate duty ratio of chopper for motoring operation at rated torque and 350 rpm

(ii) Calculate duty ratio of chopper for breaking operation at rated torque and 350 rpm.

Q. 2a) Draw the combine torque speed characteristics of three phase induction motor driving the fan type of load. Comment on the steady state stability of the operating point. **(12)**

b) A single phase fully controlled rectifier feeds DC motor drive connected to the constant torque load. Discuss the operation of converter to reduce the motor speed. Support your answer with output voltage and current waveforms of the converter. **(08)**

Q. 3a) Explain the effects of unbalanced source voltages on the operation of three phase induction motor. Justify the presence of harmonic components in the torque. **(14)**

b) Draw the harmonic equivalent circuit of three phase induction motor and give the expression for the harmonic current when the supply voltages are not sinusoidal. **(06)**

Q.4a) What are the braking methods of three phase induction motor. Explain the plugging type of braking with suitable torque speed characteristics. **(03+09)**

b) A 200 V, 875 rpm, 150 A separately excited dc motor has an armature resistance of 0.06 Ω. It is fed from a single phase fully controlled rectifier with an ac source voltage of 220 V, 50 Hz. The load torque is active and has the capability to rotate the motor in reverse direction. Assuming continuous conduction, calculate: **(08)**

(i) Firing angle for rated motor torque and 750 rpm.
(ii) Firing angle for rated motor torque and (-500) rpm.

Q.5a) Explain the field oriented control of three phase induction motor in rotor flux oriented reference frame. Justify the advantage in selecting rotor flux oriented reference frame for the control of three phase induction motor. **(16)**

b) Compare the status of AC and DC drives. **(04)**

Q.6a) Explain the hysteresis based current controlled implementation of three phase induction motor using VSI. **(10)**

b) In field oriented control, the current of the motor is inherently regulated. Justify the statement with the block diagram of field oriented control of induction motor in stator flux oriented reference frame. (Mathematical equations and derivation of coupling terms are not expected). **(10)**

Q.7a) Explain the hysteresis based DTC method of three phase induction motor. Draw the look up table and discuss the effect of tangential and axial component of active switching vector on the operation of three phase induction motor. **(12)**

b) A 440 V, 50 Hz, 6 pole, star connected, 3 phase squirrel-cage induction motor has following parameters referred to stator: Rs=6 Ω, Rr'=3 Ω, Xs= Xr'=1 Ω.

Normal full load slip is 0.05.

The motor is fed from a voltage source inverter, which maintains a constant V/F ratio. For an operating frequency of 10 Hz. Calculate the breakdown torque as a ratio of its value at the rated frequency. What should be the V/F ratio at 10 Hz so that the breakdown torque at this frequency remains the same as at rated frequency. **(08)**

ME (Elect / PE&PS) Sem - II
Power System Dynamics & Control.

Lib
02-05-15

Bharatiya Vidya Bhavan's
SARDAR PATEL COLLEGE OF ENGINEERING
(An Autonomous Institution Affiliated to University of Mumbai)
END SEMESTER EXAMINATION

Class: M.E. (Electrical) **Branch: Power Electronics and Power System**

Subject: PSDAC (EE653) **Duration: 4 Hrs.**

SEM: II **Marks: 100**

Note : (1) Question No. 1 is **compulsory**
(2) Attempt **any four** questions from remaining five questions

Master
2/05/15

Q.1

Fig.1 shows the system representation applicable to thermal generating station consisting of four 555 MVA, 24 KV, 60 Hz units **20**

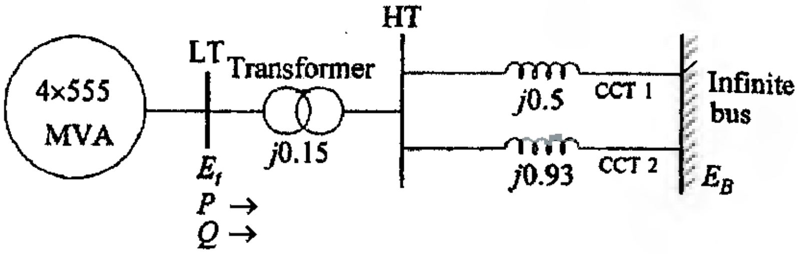


Fig. 1

The network reactances shown in figure are in per unit on 2220 MVA, 24 KV base (Referred to LT side of the step up transformer). Resistances are assumed to be negligible.
The post fault system condition in per unit on the 2220 MVA, 24 KV base is as follows:

$P = 0.9$ $Q = 0.3$ (overexcited) $E_t = 1.0\angle 36^0$ $E_B = 0.995\angle 0^0$

The generators are modeled as a single equivalent generator represented by the classical model with the following parameters expressed in per unit on 2220 MVA, 24 KV base:

$X'_d = 0.3$ $H = 3.5\ MW.s/MVA$

(a) Write the linearized state equation of the system. Determine the eigen values, Damped frequency of oscillation in Hz, damping ratio and undamped natural frequency for each of the following values of damping coefficient (in pu torque/ pu speed) :
(i) $K_D = 0$ (ii) $K_D = -10.0$ (iii) $K_D = 10.0$

(b) For the case with $K_D = 10.0$, find the left and right eigenvectors, and participation matrix. Determine the time response if at t= 0, $\Delta\delta = 5^0$ and $\Delta\omega = 0$.

Q.2

a) Derive classical transfer function of a hydraulic turbine. **10**

ME(Elec/PE&PS), Sem- II, 2/5/15.
Power System Dynamic & Control

b) Write short note on "Power system stability " 10

Q.3

A 20 MVA, 50 Hz generator delivers 18 MW over a double circuit line to an infinite bus. The generator has kinetic energy of 2.52 MJ/MVA at rated speed. The generator transient reactance is $X_d' = 0.35$ pu. Each transmission circuit has R = 0 and a reactance of 0.2 pu on a 20 MVA base. $|E'| = 1.1$ pu and infinite bus voltage $V = 1.0\angle 0^0$. A three-phase short circuit occurs at the midpoint of one of the transmission lines. Plot swing curves with fault cleared by simultaneous opening of breakers at both ends of the line at 2.5 cycles and 6.25 cycles after the occurrence of fault. Also plot the swing curve over the period of 0.5 s if the fault is sustained. 20

Q.4

a) In the systems shown in Fig. 2, a three-phase static capacitive reactor of reactance 1 pu per phase is connected through a switch at motor bus bar. Calculate the limit of steady state power with and without reactor switch closed. Recalculate the power limit with capacitive reactor replaced by an inductive reactor of the same value. Assume the internal voltage of the generator to be 1.2 pu and that of the motor to be 1.0 pu. 10

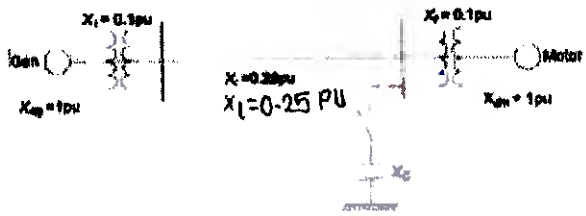


Fig.2

b) What is equal area criterion? Illustrate the equal area criterion of stability for several types of disturbances in a single machine infinite bus bar system. 10

Q.5

a) Which are methods of transient stability enhancement? Explain in detail Steam turbine fast valving. 10

b) What is Voltage stability? Give in detail factors influence on the voltage stability. 10

Q.6

a) Write short note on "Higher order modeling of synchronous machine" 10

b) Find the critical clearing angle for the system shown in Fig. 3 for a three phase fault at the point P. The generator is delivering 1.0 pu power under Prefault conditions. 10

ME (Elect / PEPS), Sem-II, 2/5/15
Power System Dynamic & Control

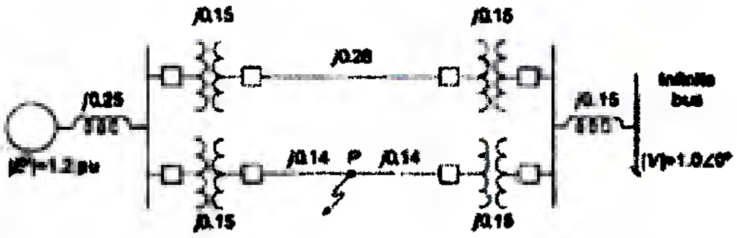


Fig. 3

MEC Elect / Power Elect. & Power Systems, Sem-II. 5/5/15.
Comp. Application in power system
05/05/015

BHARARATIYA VIDYA BHAVAN'S

SARDAR PATEL COLLEGE OF ENGINEERING

Munshi Nagar Andheri (West), Mumbai 400 058

(An Autonomous Institution Affiliated to University of Mumbai)

End Sem Examination

CLASS/SEM: **ME (Electrical PEPS/ II**
Subject: CAPS

Total Marks: **100**
Duration : **4 hour**
Date : **05/05/2015**

NB: Answer any five Qs from Qs I to Qs VII
Any extra question answered (more than five) should be self cancelled.
Assume suitable data & draw neat diagrams wherever required

MASTER FILE

Qs.I

a. i) For the network of Fig-1(a), form the primitive matrices [z] & [y] and obtain the bus admittance matrix by singular transformation. The data is given in Table-1(a),. **(5)**

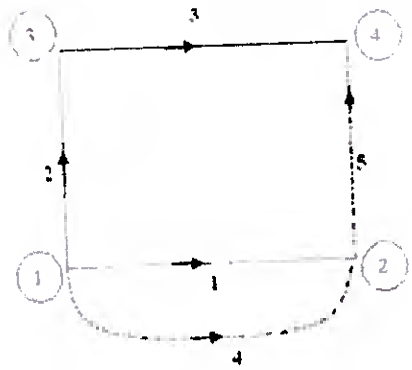


Fig-1(a)

Elements	Self impedance	Mutual impedance
1	j 0.6	-
2	j 0.5	j 0.1(with element 1)
3	j 0.5	-
4	j 0.4	j 0.2 (with element 1)
5	j 0.2	-

Table-1(a)

ii) Given that the self impedances of the elements of a network referred by the bus incidence matrix given in table-1(b) are equal to: Z1=Z2=0.2, Z3=0.25, Z4=Z5=0.1 and Z6=0.4 units, draw the corresponding oriented graph, and find the primitive network matrices. Neglect mutual values between the elements. **(5)**

A =

-1	0	0
0	-1	0
0	0	-1
1	-1	0
0	1	-1
1	0	-1

Table-1(b)

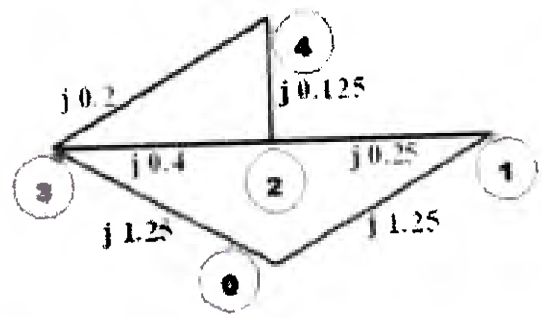


Fig-1(b)

b. Form the bus impedance matrix for the network shown in Fig-1(b). **(10)**

page-1

ME(Elect / PE&PS), Sem-II, 5/5/15.
Comp. Application in power system

Qs.II

a. In figure-2(a), Generators G1 & G2, each 100 MVA are running on no load at their rated voltage and rated frequency with their emfs in phase. The neutral of each generator is grounded through a current limiting reactor of 0.25/3 per unit. The system data is expressed in per unit on a common 100 MVA base & is tabulated below in table-2(a). Using bus impedance matrix, determine the fault current, bus voltages and line currents for a double line to ground fault at bus 3 through a fault impedance Z_f = j0.1 per unit. **(15)**

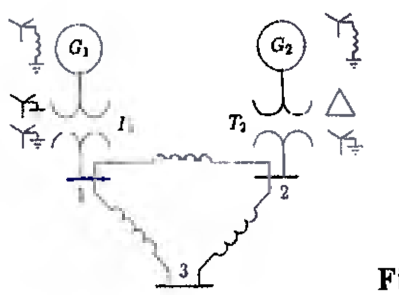


Fig-2(a)

Item	X^1	X^2	X^0
G_1	0.15	0.15	0.05
G_2	0.15	0.15	0.05
T_1	0.10	0.10	0.10
T_2	0.10	0.10	0.10
L_{12}	0.125	0.125	0.3
L_{13}	0.15	0.15	0.35
L_{23}	0.25	0.25	0.7125

Table-2(a)

b. The per unit bus impedance matrix for the power system is given by:

$$Z_{bus} = j\begin{bmatrix} 0.045 & 0.0075 & 0.03 \\ 0.0075 & 0.06375 & 0.03 \\ 0.03 & 0.03 & 0.21 \end{bmatrix}$$

A 3 phase fault occurs at bus 3 through Z_f= j0.19pu. Using the bus impedance matrix calculate the fault current, bus voltages and line currents during fault. Z_{12}=j0.75 pu, Z_{13}=j0.3 pu and Z_{23}= j0.45 pu. **(5)**

Qs.III

a. For the network shown in figure-3(a), find out the bus impedance matrix. The required data is given in Table-3(a). **(15)**

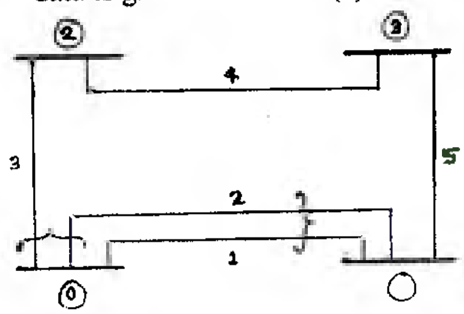


Figure-3(a)

Element no.	Self: Bus code p - q	Self: Impedance $z_{pq,pq}$ (p.u.)	Mutual: Bus code r - s	Mutual: Impedance $z_{pq,rs}$ (p.u.)
1	0 - 1(1)	j0.4	0 - 1(2)	j0.2
2	0 - 1(2)	j0.5		
3	0 - 2	j0.5	0 - 1(1)	j0.1
4	2 - 3	j0.4		
5	1 - 3	j0.6		

Table-3(a)

b. Write a note on contingency analysis in power system. **(5)**

ME (Elect), PE(PS), Sem - II, 5/5/15
Comp: Application in power system

Qs.IV

a. Explain the procedure for Three Phase Load Flow Analysis. (10)

b. Mention the steps involved & algorithm for Optimal Power Flow Solution of a power system. (10)

Qs.V

a. Figure-5(a) shows the one line diagram of a simple three bus power system with generators buses 1 and 3. The magnitude of voltage at bus 1 is adjusted to 1.05 pu. Voltage magnitude at bus 3 is fixed at 1.04 pu with a real power generation of 200 MW. A load consisting of 400 MW and 250 Mvar is taken from bus 2. Line impedances are marked in pu on a 100 MVA base, and the line charging susceptances are neglected. Obtain the power flow solution by the Newton-Raphson method at the end of first iteration. (10)

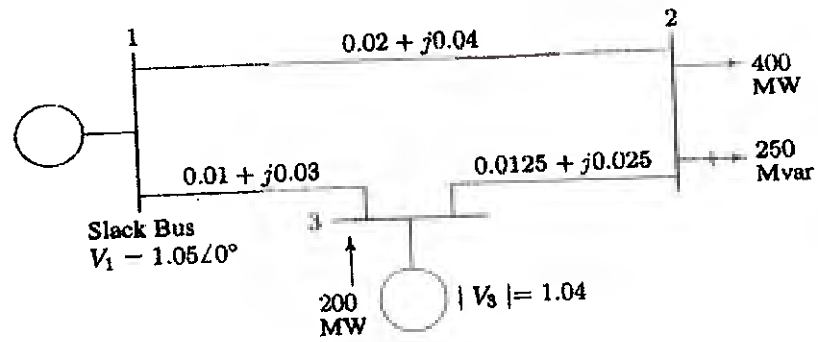


Figure-5(a)

b. With reference to above problem, obtain the power flow solution by Fast Decoupled method at the end of first iteration. Give comment on the results obtained by NR method and FDC method. (10)

Qs.VI

a. The fuel cost in \$/hr of three thermal plants of a power system are (10)

$$C_1 = 200 + 7.0P_1 + 0.008P_1^2 \quad \$/h$$
$$C_2 = 180 + 6.3P_2 + 0.009P_2^2 \quad \$/h$$
$$C_3 = 140 + 6.8P_3 + 0.007P_3^2 \quad \$/h$$

Where P_1, P_2, P_3 are in MW. Plant output are subject to the following limits.

$$10 \text{ MW} \leq 85 \text{ MW}$$
$$10 \text{ MW} \leq 80 \text{ MW}$$
$$10 \text{ MW} \leq 70 \text{ MW}$$

Assume the real power loss is given by the simplified expression.

$$P_{L(pu)} = 0.0218P_{1(pu)}^2 + 0.0228P_{2(pu)}^2 + 0.0179P_{3(pu)}^2$$

Where the loss coefficients are specified in per unit on a 100 MVA base. The total system load is 150MW. Consider the total power mismatch limit, $\Delta P \leq 0.01$. Determine: (a) the optimal dispatch of generation (b) real power loss (c) total fuel cost.

b. State the steps involved in computation of thermal generation in terms of cost function coefficients, for optimal hydro-thermal scheduling. **(10)**

Qs.VII

a. Obtain the basic power flow equation & then explain the procedure & algorithm for the complete load flow analysis of a balanced power system using Gauss-Seidel method. **(10)**

b. Explain a method for load flow solution of an ac system in which one or more DC links are present. **(10)**

M.E (PEPS) Sem. II

ANC

Lib 08/05/15

Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

(An Autonomous Institution Affiliated to University of Mumbai)

Total Marks :100 Duration : 4 Hour

CLASS/SEM : **M.E.(PEPS) Sem. II** SUBJECT : **ANC**

- Assume suitable data if necessary and justify the same
- Figures to the right indicate full marks
- **Question No. 1 is compulsory.**
- Out of remaining questions, attempt any FOUR questions.
- **In all FIVE questions to be attempted.**

MASTER FILE

Q. 1. a) Explain the term limit cycle. **(08)**

b) Comment on the stability for following non-linear system by using Lyapunav Theorem. **(12)**

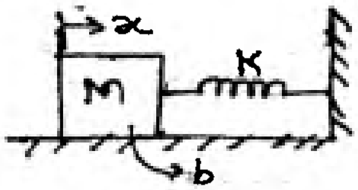
$$\dot{x}_1 = x_2 - x_1(x_2^2 + x_1^2)$$

$$\dot{x}_2 = -x_1 - x_2(x_1^2 + x_2^2)$$

(08)

Q. 2. a) State and Prove Contraction Mapping Theorem. **(12)**

b) A simple mass , spring and viscous friction system shown in figure show that system is stable .



Q. 3. a) Define the following : **(04)**

i) Phase Variable

ii) Phase Plane

iii) Phase Trajectory

iv) Phase Portrait

b) Justify the following statement : **(06)**

"Describing Function is also called as Harmonic Linearization of non-linearity's."

c) Comment on the stability for given autonomous system using LDM **(10)**

$$\dot{x}_1 = -x_1$$

$$\dot{x}_2 = -2x_1 - x_2$$

M.E. (PEPS) Sem- II

ANC

Date- 08/5/15

Q. 4. a) Explain linearization using Taylor's series ? (05)

b) What do you mean by Domain of Attractions ? (05)

c) Consider second order system given below: (10)

$$\ddot{x} + \dot{x} + x = 0$$

Draw phase trajectory using Isocline Method assuming initial condition(10,0).

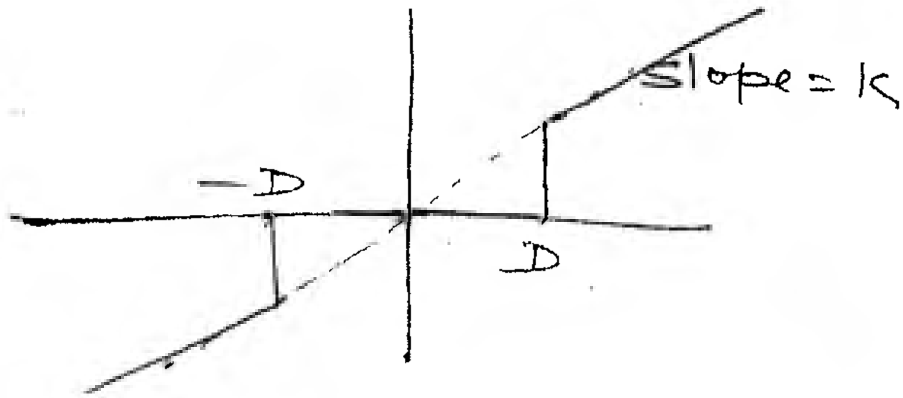
Q.5) a) What do you understand by singular points ? Determine the of singularity for each of the following differential equations . Also locate the singular points on the phase plane and draw phase trajectory for the same . (10)

i) $\ddot{y} + 5\dot{y} + 6y = 6$

ii) $\ddot{y} - 8\dot{y} + 17y = 34$

b) Explain Lyapunav Analysis for Non-Autonomous System. (10)

Q.6) a) Determine describing function of the non-linearity shown: (10)



b) Draw Phase Trajectory for the system described by

$$\ddot{x} + \dot{x} + 3x = 0$$

Use Delta Method having initial point to be (1,0) (10)

Q.7) a) Linearize the given system using input state feedback: (10)

$$\dot{x}_1 = 3x_1^2 + x_2 + u(\sin x_2)$$

$$\dot{x}_2 = e^{x1}$$

b) Illustrate linearization by feedback using example of simple pendulum. (10)