BITS, Pilani – Dubai
International Academic City – Dubai
IV year EEE, 2nd Semester 2011-12
Course Title - Advanced Power Systems (EEE C 462)
Comprehensive Examination
Full Marks – 80(Weight age 40%) Duration— 3Hours
Date: 03-06--2012

(1)A transmission line has $A=D=0.9e^{j1.5}$ and $B=150e^{j65}$. The line has, at the load end, an equipment as load having a nominal π-representation of its equivalent circuit as follows: Total series impedance of the load $=Z=101.2\ e^{j74.2}$ ohm and total shunt admittance of the same transformer $=Y=0.000738\ e^{j90}$ mho .
The load end voltage and current are V_L and I_L ,respectively. All phase angles are given in degree unit.
(a)Derive the expressions for A_1, B_1 ,C_1, D_1(in terms of A,B,C,D,Y and Z parameters) where it is given that: $V_S = A_1 V_L + B_1 I_L$ and $I_S = C_1 V_L + D_1 I_L$.
(b) In context to part (a), calculate the numerical value of A_1 (either in polar or rectangular,complex form) . [7+3 Marks] .

(2)A three phase 50 Hz. overhead transmission line (300 Km. long) has Z=40+j125 ohms and Y=j 0.001 mho(per phase), respectively. The load (total, for three phases) at the receiving end is 45 MW at 0.85 power factor(lagging) and at voltage of 220KV(L-L). Calculate the sending end voltage magnitude (per phase value, in Kilo-Volts),using $A=\cosh \gamma l$ and $B=Z_c \sinh \gamma l$. [8 Marks]

(3)(a) Develop the sequence component Impedance Matrix of Transmission lines, after starting the analysis procedure from fundamentals with necessary diagrams/figures and each step of mathematical derivation.
(b Only draw the diagram (with labeling) of the scheme of Thermal Power Generation---- No explanation [6+4 Marks]

(4)A three phase synchronous generator of reactance 1.2 p.u is connected to an infinite bus-bar(magnitude of voltage,V = 1.0 p.u) through transformers and a line of total reactance of 0.6 p.u. The generator excitation e.m.f is 1.2 p.u and its inertia constant is H= 4.0 MW-s/MVA. The damping power coefficient of the machine is 0.2 p.u/electrical radian/sec. The prime mover (mechanical) power input to the generator remains unchanged. The operating frequency is 50 Hz.
Two cases exist:----(Case 1) : The operating load angle (δ_o) = 30 degree(electrical). Case(2): The operating load angle (δ_o) = 10 degree(electrical).
In connection with the Steady State Stability Criterion:
Prove, starting the analysis from fundamentals, that Case(1) and Case (2) are exactly same so far the degree of steady state stability is concerned (Development of small perturbation model and use of Laplace Transform technique are needed), State the assumptions, if any. [8 Marks]

P. T. O
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5.) Two 25 MVA, 11.0 KV, three phase star connected Synchronous Generators are connected in parallel . The star point of one of the generators is grounded through a resistance of 3.0 ohm/phase and that of the other is isolated. A "single line –to-ground" fault occurs on phase "a" and $I_b = I_c = 0$. Each generator has positive, and zero sequence impedances as j0.18 p.u, and j0.10 p.u , respectively. The values of subtransient direct axis and quadrature axis armature synchronous reactances of each machine are : $X_d'' = j$ 0.18 p.u and $X_q'' = j$ 0.12 p.u . Fault impedance is neglected.
Calculate: (a) Negative sequence reactance of each machine.
(b)the fault current (in p.u)
(c) the current in the grounding resistor (in amps or kilo amps.) [2+ 6+2 Marks]

6 (a) Derive the expression for Transient Recovery Voltage [$e_{TRV}(t)$] of a circuit breaker, starting from fundamentals with completely labeled necessary circuit diagrams. Apply the method of Laplace Transform ,with all initial conditions relaxed.

(b) In context to part (a) question: L= 9.0 Henry , C= 0.02 μF and supply voltage per phase (r.m.s value) =220 KV.
Calculate: (i) Maximum value of Transient Recovery Voltage [$e_{TRV}(t)$]
(ii) Maximum value of RRRV [6+2+2 Marks]

7.(a) Develop the Subtransient Equivalent Circuit along the quadrature axis of a three phase Salient-pole Synchronous Generator using Constant Flux-Linkage Theorem and small perturbation model with detail mathematical derivations. Hence also derive the expressions for (i)Quadrature axis Subtransient Open Circuit Time Constant (ii) Quadrature axis Subtransient Short Circuit Time Constant-------------[4+2+1 Marks]
(b)Draw a complete connection diagram ,including C.T connections(no explanation) for percentage differential protection of a three phase star/delta transformer with terminal and polarity markings and possible labeling.-------- [5 Marks]

8(a) Derive the equation of locus (in R-X plane)of a Modified Impedance Relay, with all necessary diagrams and mathematical derivations.

(b) The following figure shows the connections of a percentage differential relay to protect one phase of a generator. The relay has $N_r / N_o = 0.1$. A high resistance fault occurs with the current distribution shown. Will the relay operate under conditions indicated in the figure(Fig.1) ? [7+5 Marks]

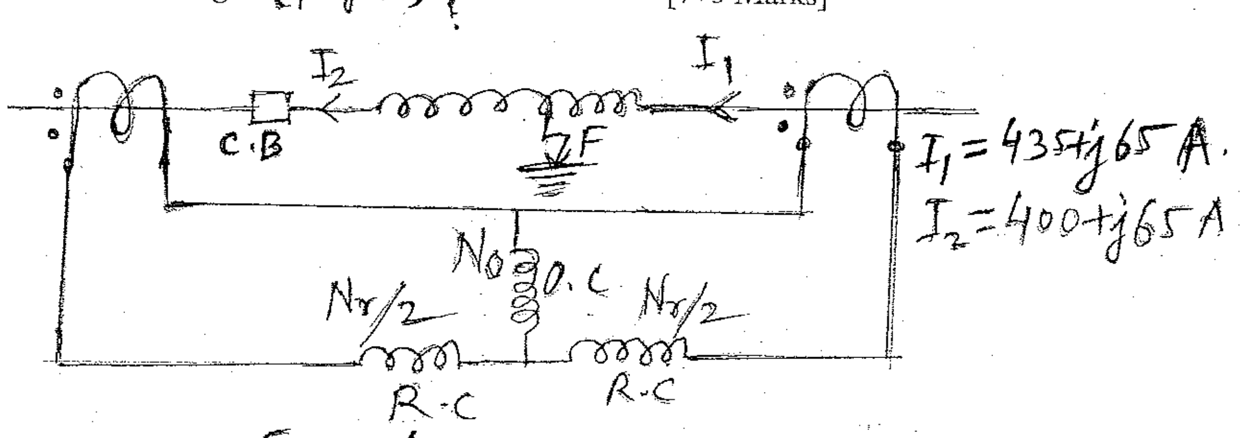

Fig.-1

BITS, Pilani – Dubai
International Academic City – Dubai
IV year EEE, 2nd Semester 2011-12
Course Title - Advanced Power Systems (EEE C 462)
Test 2(OPEN BOOK)
Full Marks – 20 (Weight age 20 %) Duration—50 min
Date: 18-04-2012
[Note: Only Text Book and handwritten class notes will be allowed]

1.)One 25 MVA, 11.0 KV,three phase Synchronous Generator is connected to a bus-bar supplying a transmission line. The star point of the generator is grounded through a resistance of 1.0 ohm/phase. A "double line –to-ground" fault occurs at the far end of the transmission line. The fault occurs on phase "b" and phase "c" while it is assumed that , $I_a = 0$. The generator has positive, negative and zero sequence impedances as j0.2 p.u, j0.15 p.u and j0.08 p.u , respectively. Each transmission line has self reactance (X_s) of j0.6 ohm and mutual reactance of any pair of transmission lines (X_m) is j0.2 ohm. Assume that fault impedance(Z^f) is zero and the given machine ratings can be assumed as base values pertaining to per unit calculations. Assume also that $E_a = 1.0+j0$ p.u . Calculate I_{a1}, I_{a2} and I_{a0} (in p.u), in complex form. [8 Marks]

(2)A single phase resistive load of 100-KVA is connected across lines "b" and "c" of a balanced three phase supply voltage of 3 KV (line-to-line). Calculate the symmetrical component currents I_{a1} , I_{a2}, I_{a0} (both magnitude and phase angle needed). Given phase sequence is "a-b-c (c.c.w)".---------------------- [6 Marks]

3.) Based on subtransient and/or transient equivalent circuits (along d-axis and q-axis) of a three phase salient pole synchronous generator, develop :
(i) An expression of X_d' involving (in terms of) X_d , T_d' and T_{do}'
(ii) An expression of X_q'' involving (in terms of) X_q , T_q'' and T_{qo}''
Given that $X_d = X_{md} + x_a$ and $X_q = X_{mq} + x_a$ ------------------------------[6 Marks]

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BITS, Pilani – Dubai
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IV year EEE, II Semester 2011-12
Course Title - Advanced Power Systems (EEE C 462)
Test 1
Full Marks – 25 (Weightage 25 %) Duration—50 min
Date: 29---02—2012

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(1) A three phase medium transmission line has: $Z= 300e^{j75}$ ohm per phase and $Y= j0.0025$ mho per phase , where the phase angle is given in "degree" unit. The power at the generating station is 40MVA at a power factor of 0.85(lag)at a voltage of 120 KV (line-to-line). There is a load of 10 MW at unity power factor at the mid -point of the line. Calculate the load voltage (in kv (line-to-line)) at the distant end of the line. Use nominal-T circuit representation of the line. [7 Marks]

(2) A three phase 50 Hz. overhead transmission line has the generalized circuit constants: $A=0.93+j0.016$ and $B=20+j140$. The load (total, for three phases) at the receiving end is 60 MW at 0.85 power factor (lagging) .The sending end voltage is 225 KV (line to line). Calculate the magnitude of receiving-end voltage (line to line). [10Marks]

(3)(a) Derive the Static Load Flow Equations in a power system network, with necessary diagrams/figures, starting from fundamentals.

(b) Derive the necessary equations for formation of Y_{BUS} (matrix) by Singular Transformation (in a power system network), with necessary diagrams/figures------------------ [4+4 Marks]

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IV year EEE, II Semester 2011-12
Course Title - Advanced Power Systems (EEE C 462)
Quiz- 2(Note: Answer Q(1) OR Q(4) and answer all other questions)
Full Marks – 7(Weightage 7 %) Duration—20 min
Date: 20---05-2012

Name---Id No.----------------

(1)A three phase synchronous generator (as a power system component) works on load and suddenly is subjected to a three phase fault.During the fault,P_e =0. Derive the expression for Critical Clearing Time(t_{cr}) in terms of δ_{cr} and δ_0 and other parameters which are given as:

f=Frequency of generated e.m.f

H= Inertia Constant of the machine

P_m =Mechanical power input in per unit .

Also given that $\delta = \delta_0$ at t=0 . The symbols have their usual meanings. Use the concerned equation in per unit. Also given that $\frac{d\delta}{dt} = 0$ at $t = 0$

(2) A three phase star connected synchronous generator (as a power system component) has Z_1 =j 0.18 p.u, Z_2 =j 0.15 p.u, Z_0 =j 0.10 p.u . For the case of a double line- to ground fault on phases "b" and "c" (and with I_a =0) , calculate I_{a1} (in p.u) using directly the formula or on the basis of particular connection of sequence networks for that fault.----------[3 marks] Also assume that $Z^f = 0$ and $E_a = 1\angle 0^\circ$

[P.T.O]

Quiz-2

(3) Zero sequence network is not involved in the case of:
(a) Single line –to -ground fault ; (b) Double line-to-ground fault
(c) Line-to- line fault ---------[1 mark]

(4) A cylindrical rotor (three phase) Synchronous generator of reactance 1.20 p.u is connected to an infinite bus-bar (Voltage magnitude =1.0 p.u), through transformers and a line of total reactance of 0.60 p.u . The excitation e.m.f (no load voltage) is 1.20 p.u and the inertia costant of the machine is , H=4.0 MW-s/MVA . The resistance and machine damping may be assumed negligible. The system frequency is 50 Hz. Calculate the frequency (in Hz.) of natural oscillations if the generator is loaded to 50% of its maximum power limit. Apply the equations related to the Steady State Stability Crieterion of power system . Also assume that mechanical power input remains constant.

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IV year EEE, II Semester 2011-12
Course Title - Advanced Power Systems (EEE C 462)
Quiz- 1
Full Marks – 8(Weightage 8 %) Duration—20 min
Date: 22---03-2012
Name--Id No.----------------

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(1) In the case of transmission line, the negative sequence reactance will be:
(a)$X_s + X_m$ (b)$X_s + 3X_m$ (c) $X_s - X_m$ (d)$X_s + (1/2)X_m$----[1 mark]

(2) Write the expression for $[A]^{-1}$ -------[1 mark]

(3) When [U] is an unit matrix, then the matrix product, $[A]^T [A]^*$ will be :
(a) [A] [A] (b) 3[U] (c) [U] (d) 3 [A] ------------[1 mark]

(4) Draw the interconnection of the sequence networks for a " Single line-to ground" Fault (labeled diagram).-----------[2 marks]

(5) A delta connected resistive load is connected across a balanced three phase supply of 400 volts (line to line) as shown in Fig.1. Calculate symmetrical components (positive and negative sequence) of the current through the 20 ohm resistor. ------------------------[3 marks]

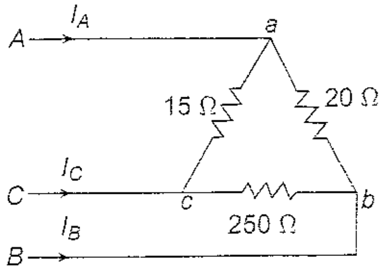

Fig. 1 Phase sequence *ABC*