BITS, Pilani – Dubai
International Academic City – Dubai
IV year EEE, 1st Semester 2012-13
Course Title - Advanced Power Systems (EEE C 462)
Comprehensive Examination
Full Marks – 80 (Weightage 40 %) Duration—3 hrs
Date: 06-01-2013

(1) A three phase 50 Hz. overhead medium 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 MVA at 0.80 power factor (lagging) .The sending end voltage is 220 KV (line to line). Calculate the magnitude of receiving-end voltage (line to line). [10Marks]

2.) Two 25 MVA, 11.0 KV (line-to-line), three phase star connected Synchronous Generators are connected in parallel . The star points of both the generators are isolated. A " line –to-line" fault occurs between phase "b" and phase " c", with I_a =0 . Each generator has positive sequence impedance of j0.2 p.u and subtransient reactances : $X_d'' = j0.10\ p.u\ and X_q'' = j\ 0.20\ p.u$. Fault impedance is neglected.
Calculate:
(a)The fault current (in p.u)(in kilo-amps).
(b) Voltages of healthy phase and phase "b"(in kilo-volts) [4+3+2 Marks]

3) A three phase salient-pole synchronous generator having direct and quadrature axes steady state synchronous reactances (X_d and X_q) of 0.75 p.u and 0.55 p.u, respectively is connected to an infinite bus-bar(magnitude of voltage,V = 1.0 p.u) through transformers and a line of total reactance of 0.5 p.u. The generator excitation e.m.f is 1.2 p.u and its inertia constant is H= 3.5 MW-s/MVA. The damping power coefficient of the machine is 0.2 p.u/electrical radian/sec. The operating load angle (δ_o) = 20 degree(electrical). The prime mover (mechanical) power input to the generator remains unchanged. The total amount of transformer and line reactance is to be considered in series with X_d for all types of calculations needed. The system frequency is 50 Hz. All reactances are given in per phase. [Given formula for Machine only: $P_e = \frac{V_t E_f}{X_d}\sin\delta + \frac{V_t^2}{2}\left(\frac{1}{X_q} - \frac{1}{X_d}\right)\sin 2\delta$]
In connection with the Steady State Stability Criterion:
(i) Develop the Differential Equation in $\Delta\delta$ (Small Perturbation Model).
(ii) Applying Laplace Transform(initial conditions being relaxed) to the D.E in (i), develop the Characteristic Equation and find out the roots.
(iii) Hence, comment on the steady state stability aspect of the machine. [6+5+1 Marks]

(4) (a)With reference to the sudden opening of a circuit breaker at $t = 0$,draw the necessary circuit diagram and develop the concerned differential equation and finally prove (using Laplace Transform): $e_{TRV}(t) = E_m(1 - \cos\frac{t}{\sqrt{LC}})$, where the symbols carry their usual meanings.-[8 marks]
(b) Draw the labeled view of a Vacuum Circuit Breaker (VCB)----[4 marks]

(5)Derive the necessary equations of a "Modified Impedance Relay" (with necessary circuit diagram) and finally develop the Relay Locus in R-X plane.-------[6+2 marks]----------[P.T.O]

(6)(a) Starting from fundamentals develop the Sequence Impedance Matrix of transmission line , with labeled diagram, where the self reactance and mutual reactance between each pair of lines are given as "X_s" *and* "X_m", *respectively.*

(b) The voltages at the terminals of a balanced load consisting of three 20.0 Ω , Y-connected resistors are: $V_{an} = 200e^{j0}, V_{bn} = 100e^{j255.5}, V_{an} = 200e^{j151}$ *volts* , where the angles are given in degrees. Find the power (in watts) expended in the 20 ohm resistors, applying Theory of Symmetrical Components.----------[6+5 marks]

(7) Develop the second order differential equation (either in "voltage" or " current") in a long transmission line(with schematic labeled diagram of a long line) .Solve this equation using Laplace Transform, with initial conditions being defined properly. ---------[8 marks]

8) A synchronous generator delivers power to the power system as shown in Fig. 1. The mechanical input to the synchronous generator has been suddenly increased from 0.3 to 0.7 p.u(as shown in Fig.2) . Using Equal Area Crieterion, prove that 1.92 $\cos(\delta_2)$+ 0.7 (δ_2) =2.00 [10 Marks]

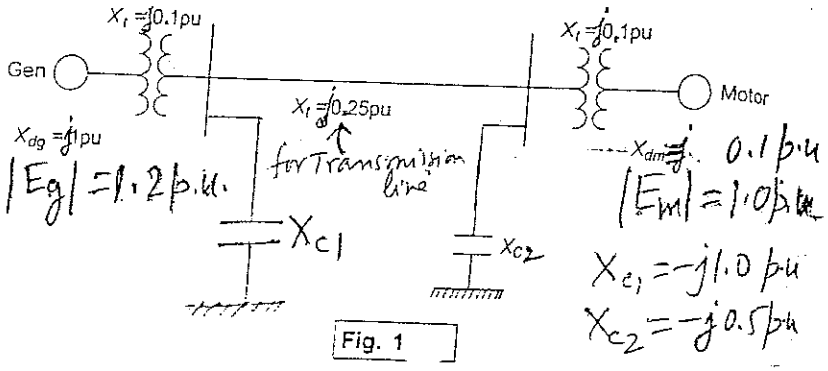

Fig. 1

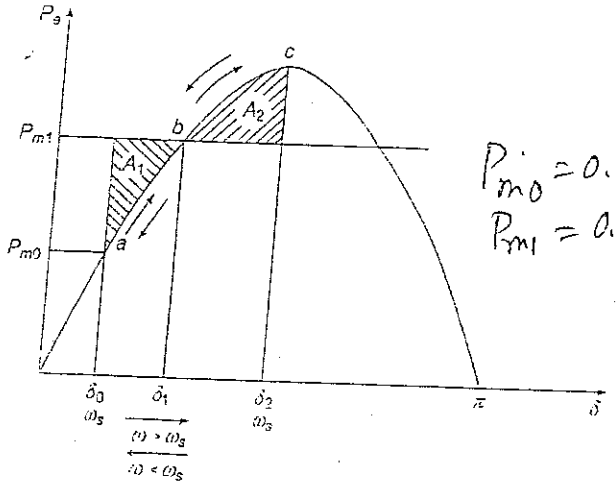

Fig. 2

BITS, Pilani – Dubai
International Academic City – Dubai
IV year EEE, 1st Semester 2012-13
Course Title /Course No.- Advanced Power Systems (EEE C 462)
Test 2(OPEN BOOK)
Full Marks – 20 (Weight age 20 %) Duration—50 min
Date: 27-11-2012
Instructions: Only text book and handwritten class notes are allowed

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1.) Two 20 MVA, 11.0 KV (line-to-line), three phase star connected Synchronous Generators are connected in parallel and feeding the load . The star point of one of the generators is grounded through a resistance of 2.5 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, negative and zero sequence impedances as j0.18 p.u, j0.15 and j0.10 p.u , respectively. Fault impedance(Z^f) is neglected.
Calculate:
(a)The fault current (in p.u), in complex polar form.
(b) The current(magnitude) in the grounding resistor (in kiloamps) [6+2 Marks]

2.)A Synchronous generator is feeding 250MW to a large 50Hz network over a double circuit transmission line. The maximum steady state power that can be transmitted under different conditions, are as follows :-

Prefault ---------- 500 MW
During fault----------175 MW
Post Fault ---------- 350MW

Estimate the critical clearing angle in which the circuit breakers must trip so that synchronism is not lost. Consider that the maximum load angle (δ_{max}) is the angle at the point of intersection by the 250 MW line with the post-fault P- δ curve. Apply the "Equal Area Criterion" method. [8 Marks]

3.) Based on the established subtransient equivalent circuit (along q-axis) of a three phase salient pole synchronous generator, develop an expression of X_q'' involving (in terms of) X_q , T_q'' and T_{qo}'' , where the symbols carry their usual meaning.
----------[4 Marks]

BITS, Pilani – Dubai
International Academic City – Dubai
IV year EEE, I Semester 2012-13
Course Title - Advanced Power Systems (EEE C 462)
Test 1
Full Marks – 25 (Weightage 25 %) Duration—50 min
Date: 09---10—2012

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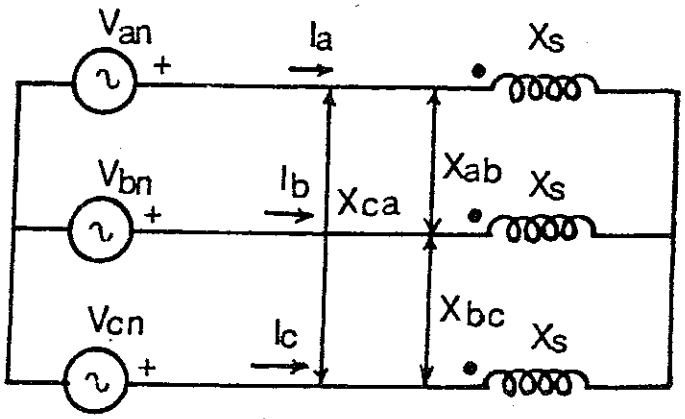
(1) A three phase medium transmission line has: $Z = 300e^{j75}$ ohm per phase and $Y = j0.0025$ mho per phase , where the phase angle is given in "degree" unit.The power at the generating station is 40MVA at a power factor of 0.85(lag)at a voltage of 120 KV (line-to-line). There is a load of 10 MW at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

(2)Derive the expression for any one parameter (out of A,B,C,D-paramters) for the π representation of a medium transmission line, starting from fundamentals, with necessary diagrams/figures.[8 Marks]

(3)With reference to the following figure, the given data are:

$V_{an} = 100\, e^{j\,0}$, $V_{bn} = 60\, e^{j\,60}$, $V_{cn} = 60\, e^{j\,120}$, $jX_{ab} = jX_{bc} = jX_{ca} = j5.0$ ohms , $j\,X_s = j12.0$ ohms. Calculate V_{a1} , V_{a2} , V_{a0} and I_a using the theory of Symmetrical Components. Phase angles are given in degree units. [7 Marks]



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BITS, Pilani – Dubai
International Academic City – Dubai-------Name of the student----------
IV year EEE, I Semester 2012-13---------Id No.of the student----------
Course Title - Advanced Power Systems (EEE C 462)/ Quiz-1
Full Marks – 16 (Weightage 8 %) Duration—20 min
Date: 18—10—2012

(1) Write the Differential Equation (in voltage or current) for a long transmission line, with the meanings of the concerned symbols. [2 Marks]

(2) A medium line has $= 40 + j125\ ohm\ and\ Y = j10^{-3}\ mho$. Calculate the value of the parameter A (considering either T-model or π-model of the line). ------[2 Marks]

(3) Write the final condition (equation) for achieving **"Zero Voltage Regulation"** in a Short Transmission Line, with the meanings of the concerned symbols.------[2 Marks]

(4) Write the expression for the matrix, $[A]^{-1}$ ----------[2 Marks]

(5) Fill in the blank: $\alpha - \alpha^2$=------ -----[2 Marks]

(6) "Fifth harmonic component of voltage or current is analogous to its Positive Sequence Component"------TRUE or FALSE ? -----[1 Mark]

(7) "Third harmonic component of voltage or current is analogous to its Zero Sequence Component"------TRUE or FALSE ? -----[1Mark]

(8) Draw the Primitive Machine Model diagram(labeled) of a three phase salient-pole Synchronous Generator with one field winding and two damper windings (placed on two axes).-----------[2 Marks]

[P.T.O]

(9) With reference to the question(8), write $\Delta\lambda$-Δi relations(equations in per unit) of the windings(coils) placed on direct axis of the said Primitive Machine Model Diagram where $\Delta\lambda$ represents the small perturbation(change) in winding flux-linkage and Δi represents the small perturbation(change) in winding current. You may (also) use other symbol for flux-linkage . Meaning of all the symbols should be clearly written-----[2 Marks]