BITS, Pilani – Dubai
International Academic City – Dubai
IV year EEE, 1st Semester 2013-14
Course Title - Advanced Power Systems (EEE C 462)
Comprehensive Exam./ F.M-80 (40%) / Duration-3hrs /Date-09-01-2014

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1)(a) Derive the condition for "Zero Voltage Regulation" in a short transmission line ,with necessary phasor diagram and other geometrical constructions/diagrams .

(b) A three phase 50 Hz transmission line is 400 km. long . The voltage at the sending end is220kv(line-to-line). Resistance=0.125 Ω/km. ,series reactance(inductive)=x=j0.4 ohm/km., shunt admittance=y= j 2.8×10^{-6} mho/km. Given that: $A = 1 + \frac{1}{2}YZ$ and $C = Y\left[1 + \frac{1}{6}YZ\right]$. Find the following:---(i) The sending end current and receiving end voltage when there is no-load on the line . (ii) The maximum permissible line length if the receiving end no-load voltage is not to exceed 235 kv(line-to-line) . State any approximation, if needed.----[5+10 marks]

(2)Draw the complete Percentage Differential Protection Scheme (labeled) of a three phase star/delta transformer with necessary explanations/descriptions. ----[8 Marks]

(3)(a) Develop the sub-transient equivalent circuit of a three phase salient pole synchronous generator, along quadrature(q-) axis, using Constant Flux-linkage Theorem and "flux-linkage – current" relations. The analysis should be presented in detail, with the complete primitive machine model (including all windings) neatly drawn.

(b)A three phase star connected 50 Hz. salient pole synchronous generator has the following data:
Rated voltage (L-L)=1.0 p.u ; Rated armature current=1.0 p.u; X_q =0.55 p.u ; X_{mq} =0.44 p.u; Subtransient q-axis armature current =200% of rated current .
Calculate leakage reactance of q-axis damper winding (in p.u).---[5+6 marks]

(4) A Synchronous generator is feeding 275MW to a large 50Hz network over a double circuit transmission line. The maximum steady state power that can be transmitted under different conditions, are given as :- Prefault ---------- 480MW and Post Fault ---------- 325MW
A solid three phase symmetrical fault occurring at the network-end of one of the lines causes it to trip(no power transmission through either of the two transmission lines). 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 275 MW line with the post-fault P- δ curve. Apply the "Equal Area Criterion" method. [10Marks]

(5) Draw the complete circuit diagram of a modified impedance relay and derive (in detail) the equation for its locus in R-X plane. Also draw the locus.------[8 marks]

(6) Draw the labeled diagram of a Vacuum Circuit Breaker(VCB) with a brief discussion on its operation.---[8 marks] .----------[P.T.O]

(7) Derive the expression for fault current and voltages of healthy phases for a "Single line-to-ground fault" , with necessary circuit diagram and sequence network diagram.---[09 marks]

(8)(a)Write the general Relay Equation with meaning of all symbols and hence derive the expression for "Pick-up Current" of an Over-current Relay.

(b) A 20.0 MVA ,11.0 KV(L-L), three phase star-connected synchronous generator has positive, negative and zero sequence impedances as j 0.18 p.u ,j0.15 p.u and j0.10 p.u , respectively. A single line-to-ground fault occurs on phase -"a" with no currents in phase-b and phase-c and with no fault impedance developed. E_a =1.0+j 0 p.u (per phase) . Calculate the fault current magnitude in per unit and in kilo-ampere (per phase).---- -[4+7 marks] *

* The generator is solidly earthed (grounded) (neutral grounded directly).

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BITS, Pilani – Dubai
International Academic City – Dubai
IV year EEE, 1st Semester 2013-14
Course Title - Advanced Power Systems (EEE C 462)
Test 2(OPEN BOOK)
Full Marks – 20 (Weight age 20 %) Duration—50 min
Date: 30-10-2012
[Note: Only Text Book and handwritten class notes will be allowed]

1.)One 25 MVA, 11.0 KV (L-L),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. [7 Marks]

(2) Derive the complete expression for Impedance Matrix , in Symmetrical Component (Sequence model) for a three phase transmission line, having self reactance=jX_s and mutual reactance between any pair of lines =jX_m. Ignore resistances. Each step of derivation should be shown. Matrix multiplication processes should also be shown explicitly.-------- [6 Marks]

(3) A three phase star connected 50 Hz. salient pole synchronous generator has the following data:
Rated voltage (L-L)=1.0 p.u ; Rated armature current=1.0 p.u; X_d =1.17 p.u ; X_{md} =1.03 p.u; Subtransient d-axis armature current =275% of rated current and Transient d-axis armature current =120% of rated current .
Calculate leakage reactances of field winding and d-axis damper winding (in p.u).---[7 marks]

BITS, Pilani – Dubai
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IV year EEE, 1st Semester 2013-14
Course Title - Advanced Power Systems (EEE C 462)
Test-1/ Full Marks – 25 (Weightage 25%) Duration—50 min Date-30-09-2013

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(1) 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 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). [8Marks]

(2) Using the nominal "π" method, find the sending end voltage of a three phase ,50 Hz medium transmission line delivering 25 MVA at 0.8 power factor to a balanced load of 132 kv(L-L). Given data: Z= 27.5+j 97.4 ohm per phase and Y= j0.00074 mho per phase . ----[9Marks]

(3) Only develop the Differential equation in "voltage " or "current" ,in a long transmission line, with necessary diagrams and explanations. **No derivation for solution of the equation is needed.** ----[8Marks]

BITS,Pilani-Dubai

2013-14/1st semester/Quiz-2/IV year(EEE)/Date—17-12-2013/Duration-20 min.

Course Title/Code---Advanced Power Systems/EEE C462----Max.Marks=14 (7%)

Marks: Q(1)-3/(2)-4/(3)-2/(4)-5 [Name/Id No.---]

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1. A synchronous generator operating at 50 Hz delivers 1.0 p.u power to an infinite bus through a transmission line whose resistance is neglected. Before the fault, the maximum power transferrable was 2.0 p.u . Calculate value of initial load angle(δ_0).

2. Derive the " EQUAL AREA CRIETERION" starting from the well-known Swing's Equation. You may use the standard mathematical formulae within the process of derivation, to reduce the steps.

3. Write the expression for "M" in Mega-Joules-sec./elect.radian , involving number of poles.

[P.T.O]

4. A power system follows this dynamics :---$M\frac{d^2\delta}{dt^2}+B\frac{d\delta}{dt}+K\delta=P_m$, where the symbols have their usual meanings and also P_m = Constant . Derive the necessary equations for assessment of the steady state stability of the given system. State the necessary assumptions.

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BITS,Pilani-Dubai

2013-14/1st semester/Quiz-1/IV year(EEE)/Date—20-10-2013/Duration-20 min.

Course Title/Code---Advanced Power Systems/EEE C462----Max.Marks=16 (8%)

Marks: Q(1)-3/(2)-4/(3)-2/(4)-2/(5)-3/(6)-2 [Name/Id No.---]

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1. A short transmission line has R=0 and X=18.0 ohms/phase. Line current is 1000.0 amp/phase at V_R =230 KV (L-L). For same magnitude of V_R , calculate the value of power factor angle at the receiving end to achieve **Zero Voltage Regulation(Z.V.R) .**

2. With reference to Question(1), why is only the phasor diagram at leading power factor considered and why not the phasor diagrams at lagging p.f and unity power factor are considered?----Explain with the help of concerned phasor diagrams.

3. Calculate the value of $\alpha - \alpha^2$ [P.T.O]

4. **" Zero sequence component M.M.F-s are similar to 5^{th} harmonic components in a three phase system for phase sequence given as : A-B-C (C.C.W) "**------- TRUE or FALSE ? and Why ?

5. For a three phase transmission line, prove that $[Z]_s=[A^{-1}]\,[Z][A]$,where the symbols bear their usual meanings. $[Z]_s$ indicates the impedance matrix in symmetrical component or sequence component model and $[A^{-1}]$ indicates the inverse of the matrix [A].

6. Draw the final diagram (only) of connection of sequence networks for a single line-to ground fault with proper labeling.

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