(٤) قوى كهربية

TANTA UNIVERSITY

Electrical Power and Machines Department

Faculty of Engineering

Final EXAM 2017/2018- First Term

Course	Electrical Machines (4)(EPM4117)	Time Allowed	3 hours
Students	4th Year (Electrical Power and Machines)	Total Points	120
Date	Wed. January 3rd 2018	Number of pages	FOUR

قبل أن تبدأ إجابتك الرجاء قراءة التعليمات العامة الآتية والالتزام بها بكل دقة:	
1. اكتب رقم السؤال بوضوح.	2. استخدم الرسومات التوضيحية ذات البيانات الواضحة والكاملة كلما أمكن.
3. أجب بوضوح سواء باللغة الإنجليزية أو العربية.	4. لا يشترط الإجابة بترتيب الأسئلة في ورقة الامتحان.
5. افترض قيمًا معقولة لأية بيانات ناقصة.	6. فيما عدا الرسومات لا تستخدم القلم الرصاص إلا في أضيق الحدود
7. ابدأ إجابة كل سؤال في بداية صفحة جديدة	8. تجنب تمامًا في إجاباتك استخدام: • اللونين الأحمر والأخضر • سائل التصحيح corrector
9. يُخصص حوالي 20% من تقييم درجة كل لسؤال على جودة تنظيم الإجابة ودقة الرسم	

Answer ALL the following FIVE questions and problems:

The first question

Choose the correct answer/answers for the following statements. **ONLY write down the question number followed by your choice/choices** in your answer sheet:

1.	In a four-pole machine, pole pitch in mechanical angle measurement is: a) 180 degrees b) 90 degrees c) 60 degrees d) 45 degrees
2.	The induced emf in synchronous machines depends on a) rotor speed b) load angle c) field current d) load
3.	Machine winding is distributed in order to: a) eliminate a certain space harmonic b) save copper c) get sinusoidal mmf distribution d) facilitate handling
4.	For a salient pole synchronous machine, load angle δ at maximum power is: a) always less than 45 electrical degrees b) between 45 and 90 electrical degrees c) slightly less than 90 electrical degrees d) more than 90 electrical degrees
5.	Cylindrical-rotor type is generally used in a) low voltage alternators b) high speed alternators c) low speed alternators d) steam-turbine driven alternators
6.	Synchronous condenser is an: a) under-excited synchronous generator b) over-excited synchronous generator c) under-excited synchronous motor d) over-excited synchronous motor

Please Turn Over

7.	If an alternator connected to a network is operating at a leading power factor, it means that a) the alternator is over-excited b) the alternator is under-excited. c) the torque angle is negative. d) the load is capacitive
8.	Infinite bus bar system is characterized by a) constant frequency b) constant voltage c) high internal impedance d) all a) , b) and c) choices
9.	The active power of a grid-connected synchronous generator is influenced by: a) prime mover speed b) prime mover power c) excitation level d) type of load
10.	Increasing field current of a stand-alone alternator results in an increase in a) terminal voltage b) frequency c) load power factor d) load reactive power
11.	In which case the terminal voltage rise of a loaded alternator is more: a) When unity power factor load is switched off b) When leading power factor is switched off c) When lagging power factor is switched off d) None of a) , b) and c) choices
12.	Percentage speed regulation of synchronous motors is always a) positive b) zero c) negative d) between -10% and 10%
13.	The main function of governor is to keep prime mover operating a) at constant power b) at constant speed c) at constant torque d) in synchronism with the network
14.	Synchronous motor can develop synchronous torque only when it is a) loaded b) over-excited c) running at synchronous speed d) running at no-load
15.	The operating speed of a synchronous motor can be changed to another value by changing a) load b) supply frequency c) supply voltage d) excitation
16.	When the excitation of an unloaded salient pole synchronous motor is switched off, the motor will: a) stop b) continue running at the same speed. c) continue running at a lower speed. d) none of the above
17.	Two alternators G1 and G2 are running in parallel to supply a fixed load. What will happen when the excitation of G1 is increased?: a) frequency will increase b) Total reactive power will increase c) Reactive power sharing will change d) Active power sharing will change

Please Turn Over

The Second Question

1.	Explain the **motivations** of **distributing** and **chording** stator windings of synchronous machines. Then, with aid of mathematical relations (without derivation) **show** how do they affect induced emf..
2.	**Clarify** with *suitable mathematical relations* the effect of *space harmonics* on the induced emf in synchronous machines.
3.	For *a salient-pole synchronous machine*: a) **Derive and** draw the equivalent circuit b) **Sketch** with all data the power-angle characteristics neglecting armature resistance c) **Draw** the phasor diagram for MOTORING mode operating at unity power factor
4.	A Y-connected six-pole synchronous generator is of 50-kVA, 380-V, 50 Hz,. It has a per phase synchronous impedance of 0.4 + j 1.2 ohm. The generator has friction and windage losses of 1.5 kW and core losses of 1.0 kW. The field winding has been adjusted so that terminal voltage is 400-V at no-load .At *full load current and unity power factor*, **calculate**: a) Terminal voltage. b) Generator efficiency c) Prime mover torque

The Third Question

1.	**Sketch** electrical load diagram of a cylindrical rotor synchronous machine. **Show** the following: a) on the graph points that satisfy the following conditions Point 1: at a specific generator active power at a certain excitation level. Point 2: at a specific motoring active power at a certain leading power factor. Point 3: at a specific generator load angle at a certain leading power factor. Point 4: at a specific motor load angle at a unity power factor b) how to obtain **torque against angle** characteristics for **generator** mode.
2.	Explain importance of operating generators in parallel. Then show • Necessary requirements • One method employed to ensure successful synchronization.
3.	**Define** voltage regulation. Explain why it is important to be **determined** accurately rather than measured experimentally.
4.	A 1000-kVA, 2000-V, 50-Hz three-phase alternator has an armature resistance of 0.2 ohm/phase. The following table shows the laboratory results of open-circuit (OC) test.

Field current, A	10	20	25	30	40	50
OC line voltage, V	800	1500	1760	2000	2350	2600

At short-circuit, rated armature current is obtained when field current is 28.9-A.

The field current is adjusted such that no-load phase voltage is 1080-V. Using **ampere-turn (mmf) method** estimate the full load percentage regulation at 0.75 lagging power factor.

Please Turn Over

The Fourth Question

1.	**Sketch** the complete (total) mechanical load diagram for synchronous motor. **Explain** how it can be used to **plot V-curve** for different loads (show all details and how to obtain the stability limits)
2.	**Show** how can *synchronizing torque* be developed to regain the synchronous operation of two generators connected in parallel when a) one generator has an increase in prime mover fuel. b) one generator has a decrease in excitation
3.	**Explain** how can two generators operating in parallel be adjusted in order to: a) change system frequency without affecting active power sharing. b) change reactive power sharing without affecting system voltage.
4.	A 250 MVA alternator is connected to a grid of 50 Hz. The governor characteristics result in a uniform frequency drop of one Hz per 100 MW load. **How much the generator active power sharing** for the following setting of no-load frequency?: a) 50 Hz b) 49 Hz c) 52 Hz Clarify your answer with house diagrams

The Fifth Question

1.	Explain the effect of damper windings on **load angle time response** of a synchronous machine when subjected to a) a medium load increase b) a heavy load increase c) a medium load decrease
2.	**Investigate the reasons** of the following practical situations: a) When starting a synchronous motor SM using a pilot starter, is shaft is broken once SM stator is switched on to the supply. b) When increasing the fuel supply to a synchronous generator system, it stepped out of synchronism. c) Protection system switched off a synchronous generator when it is connected in parallel with a grid
3.	The excitation of a synchronous generator is increased. **What will happen** if the generator was: a) stand-alone. b) connected to an infinite grid

Good Luck and best wishes

Prof. Essam M. Rashad and Exam committee

راجعه قوى
٢٠١٨/١/٦

Tanta University

Department: Elec. Power and Machines Engineering
Total Marks: 75 Marks

Faculty of Engineering

Course Title: Applications of Computer in Electrical Power Systems		Course Code: EPM4119 Year: 4th
Date: 6 Jan 2018	Allowed time: 3 hour	No. of Pages: 1page

Answer the following questions: [**Assume** any needed information]

Question (1) (25 Marks)

a) Define the following:

1. Load flow program
2. Micro-grid
3. SCADA system
4. Optimization technique

(6 Marks)

b) Mention the stopping techniques used with load flow program, and determine the suitable technique for Newton Raphson and Gauss-Seidel methods. (6 Marks)

c) Explain how AI could be used in power system (4 Marks)

d) Compare between offline and online load flow programs. (4 Marks)

e) Compare between SCADA and WAMC system (5 Marks)

Question (2) (30 Marks)

a) Write the procedures to determine net Q of PV bus using Gauss-Seidel. (5 Marks)

b) Clarify the function of each BUS and LINE input data used in load flow program (10 Marks)

c) Write the procedures to determine the mismatch matrix used in NR. (5 Marks)

d) When the FD method is used in load flow analysis? Write the procedures needed to determine (J_1) using FD and NR methods. (10 Marks)

Question (3) (20 Marks)

a) Compare between NR and Gauss-Seidal methods. (5Marks)

b) The single-line diagram of a simple power system is shown in Figure 1. All impedances are expressed in per unit on a common MVA base. All resistances and shunt capacitances are neglected. (15 Marks)

1. **Build** the impedance matrix of this system.
2. **Calculate** the three phase fault current and voltage during fault at bus 3 in pu.

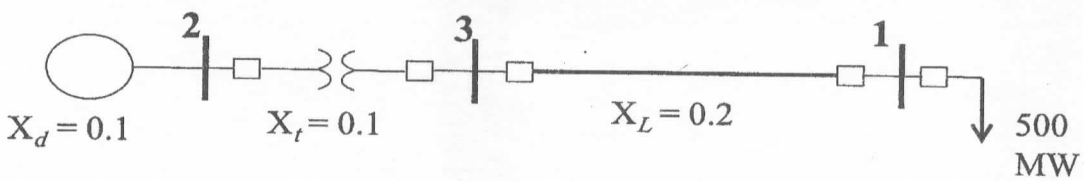


Figure 1

Best wishes
Dr. Doaa Mokhtar

ابقة قوى
٢٠١٨/١/١٠

Tanta University | Department: Elec. Power and Machines Engineering | Faculty of Engineering
Total Marks: **70 Marks**

Course Title: **Electrical Machines Dynamics**	Course Code: EPM4124	Year: 4th
Date: Jan. 10th 2018 (First term)	Allowed time: 3 hrs	No. of Pages: (2)

Remarks: (answer the following questions… assume any missing data… answers should be supported by sketches if possible)

Question number (1) **(22 Marks)**

a) Consider a separately excited **dc generator** operating under a constant speed and supplying a resistive load of R_L. **Answer** the following: **(6Marks)**

(i) **Write down** a mathematical model by which the dynamic behaviour of this generator can be predicted under a constant speed operation. **Setup** the differential equations in the appropriate matrix form

(ii) **Derive** the expressions of the generator transfer functions $\frac{I_a(s)}{V_f(s)}$ and $\frac{V_a(s)}{V_f(s)}$

b) **Write down** a mathematical model by which the dynamic behaviour of a separately excited dc motor can be predicted. **Setup** the model in the matrix form: $[U_{input}]=[A][X_{output}]$. **(6 Marks)**

c) A **separately-excited dc motor** has the following parameters: **Ra=0.5 Ω, La=0, B=0.** The motor generates an open circuit armature voltage of **240 V** at **1500 rpm** with a field current of **1.2 A.** the motor drives a linear load of $T_L = 0.06\,\omega_m$ Nm. The combined inertia of the motor and the load is **J=2.6 Kg-m²**. *With the same field current*, the machine terminals are suddenly connected to a **240 V** dc voltage source. **(10 Marks)**

(i) **Draw** the **block diagram** of this system. **Mention** the **order**, **type** and **state variables**.

(ii) **Derive** expressions of the **speed** and the **armature current** as a function of time.

(iii) **Determine** the **steady-state** values of the **speed** and the **armature current.**

Question number (2) **(26 Marks)**

Related to a three-phase induction motor dynamic modelling, answer the following:

a) **Write down** a mathematical model by which the dynamic behaviour of a three-phase induction motor can be predicted in its **natural variables**. **Mention** the **order**, **type** and **state variables** of this system. **(5 Marks)**

b) **Summarize,** ***referring to appropriate equations,*** the advantages and disadvantages of the abc-axis model. **What** is the necessary condition required to obtain the corresponding **qdo-axis** model? **(3 Marks)**

c) **Write down,** aiding with appropriate sketches, the transformation matrices required to transform the **abc-axis** model to **an arbitrary** reference frame **qdo-axis** model. **(2 Marks)**

P.T.O.

Continue Question number (2)

d) **Write down** a complete qdo-axis dynamic model valid to predict the dynamic performance of the three-phase induction motor in **a stationary reference frame**. **Draw** the dynamic qd-axis equivalent circuit. **Write down** the appropriate expressions of the corresponding qd-axis supply voltages as a function of time. **(8 Marks)**

e) **Derive** an expression of the per-unit **inertia torque**. **Show** the relation between the inertia constant and the rotor stored energy. **Write down** an expression of the per-unit electromechanical **developed torque**. **(5 Marks)**

f) **Show** how the **steady-state voltage equations** can be obtained from qdo-axis voltage equations expressed in **arbitrary reference frame**. **Derive** the steady-state **rotor** voltage equation in **space-vector form.** **(3 Marks)**

Question number (3) (22 Marks)

Related to a three-phase salient-pole synchronous machine, having one damper winding on the direct axis and one damper winding on the quadrature axis, Answer the following:

a) **Write down** the detailed expressions of the **abc-axis** flux linkage relations of this machine type. **Summarize** the main problems of the **abc-axis** dynamic model of this type of machine. **(4 Marks)**

b) **Write down,** aiding with appropriate sketches, the transformation matrices required to obtain the appropriate **qdo-axis** dynamic model (***Explain the reasons***). **Summarize**, the advantages and disadvantages of this model. **(3 Marks)**

c) **Write down** a complete qdo-axis dynamic model valid to describe the dynamic behaviour of this machine in the appropriate reference frame when it operates as **a generator**. **Draw** the dynamic qd-axis equivalent circuit. **(6 Marks)**

d) **Derive** the detailed expressions of the **dynamic** and the **steady-state electromagnetic developed-torque**. **Illustrate** the type of the different torque components. **(4 Marks)**

e) **Show** the necessary modifications that should be applied to the **model** obtained in (**c**) and the **expressions** derived in (**d**) for the following machine type: **(5 Marks)**

(i) **synchronous reluctance motor**

(ii) **cylindrical** type **permanent magnet** synchronous **generator**

WISH YOU ALL THE BEST

رابعة قوى كهربية

كلية الهندسة
قسم هندسة القوي والالات الكهربية
جامعة طنطا

امتحان الفصل الدراسي الاول للعام الجامعي 2017/2018

المادة	مقرر اختياري (2) تركيبات كهربية	الزمن	3ساعات	الدرجة	70
الفرقة	الرابعة هندسة القوي والالات الكهربية	التاريخ	13/1/2018	عدد الاوراق	3

اجب علي جميع الاسئلة التالية وافرض اي بيانات او معاملات تحتاجها في الحل

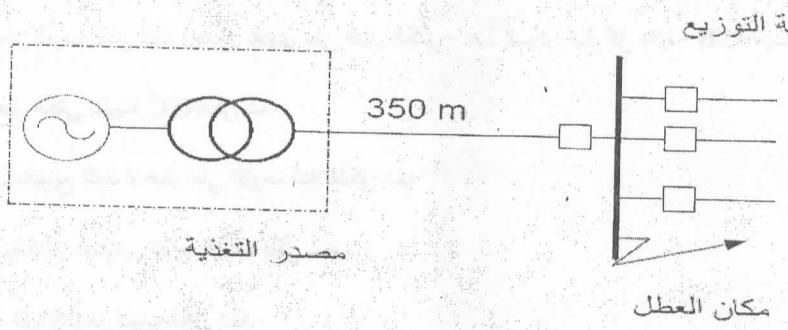
السؤال الاول (20 درجه)

1 احسب المقطع المناسب لكابل يغذي لوحة توزيع مجموع احمالها 1 ميجا فولت امبير وتبعد عن محول التوزيع مسافة 350 متر كما بالشكل علما بان.

MVA_{base}= 1 MVA MVA_{source}=500MVA

X_T =0.05 p.u Z_{cable}=0.014 ohm

اعتبر ان جهد التشغيل 380 فولت وان مساحة مقطع الكابلات المتاحه 240 مم2 وسوف يتم تمديدها فوق حوامل الكابلات في درجةحرارة 50 درجة مئوية اعتبر ان الهبوط في الجهد لهذا النوع من الكابلات =0.204ملي فولت لكل متر لكل امبير. وان هذا النوع يتحمل تيار قصر 39 كيلو امبير لمدة نصف ثانية.استخدم جدول الكابلات وجداول التصحيح المرفقة. مطلوب عمل الاختبارات الثلاثة علي الكابل



2 ما هو ATS و UPSوما هو استخدامهم ؟

السؤال الثاني (25 درجه)

1. ما معنى الصيغة التالية لاحد الكابلات (3x95+50)+25 mm^2 PVC/CU
2. اشرح مع الرسم مكونات نظام التأريض للمناطق السكنيه واذكر العوامل المؤثره على مقاومة الارضى
3. عرف مع كتابة المعادلات Luminous Intensity , Illumination, Step Voltage , Touch Voltage
4. اشرح مع الرسم نظم التأريض TN-S, TN-C, TN-C-S, TT مع التوضيح باختصار اهم المشكلات فى كل نظام وكذلك عيوب استخدام نظامى TN-C-S, TT&S فى شبكة واحده

5. مصنع طول طلعه 50 متر مطلوب تصميم شبكة ارضى له مكونه من 20 الكترود رأسى طول كل منهم 5 متر مدفونه فى تربه مقاومتها النوعية 500 Ω.m على أن يتم توصيل هذه الالكترودات معا بشريط أفقى ابعاده 4X40mm اعتبر معامل التصحيح الأفقى 0.8

6. مطلوب تصميم اضاءة مكتب ابعاده 18X8 متر وارتفاع السقف 3 متر ومستوى الاستضاءة المطلوبة يساوى 1000 lux علما بان انعكاس السقف 80% والحوائط 50% والأرضيات 30% وأن مستوى العمل يرتفع 70 سم من الأرض وأن وحدة الانارة المستخدمة تنتج فيضا قدره 2000 ليومن ومعلقة تحت السقف بمسافة 50 سم.

7. ملعب لكرة القدم مساحته 120mx60m يراد اضاءته ليلا بمصابيح قدرة كل واحد منها 1000W وأن تكون الاستضاءة منتظمة حول الملعب باستخدام أبراج عددها 12 برج وبفرض ان 40% فقط من الاضاءة تصل الى الملعب فاذا كانت شدة الاستضاءة المطلوبة 1000 Lm/m^2 وان كفاءة المصابيح المستخدمة 30 lm/w احسب عدد المصابيح فى كل برج.

السؤال الثالث (25 درجه)

عمارة سكنية مكونة من تسعة أدوار فى كل دور يوجد خمس شقق متماثلة مساحة كل شقة 120 متر مربع وأحمالها هى:

الانارة 12000VA (8 دوائر) والمخارج العامة 5000VA (4 دوائر) واثنين غساله كل منهم بقدرة 3000VA وسخان 1 بقدرة 1500VA وسخان 2 بقدرة 3500VA وثلاثة تكييفات كل منهم بقدرة 2200VA وفرن ثلاثى الاطوار بقدرة 12000VA

الاحمال العامة للعمارة: عدد 2 مصعد كهربائى قدرة كل منهم 15 كيلو وات ومحطة رفع المياه بعدد 4 طلمبة احدى هذه الطلمبات احتياطية قدرة كل واحدة 15hp وكفاءتها 80%

المطلوب

a. تصميم الدوائر الفرعية لكل شقه (جدول يحتوى على التيار الكلى- عدد الدوائر-تيار كل دائرة- C.B-مساحة الكابل)

b. احسب الحمل الكلى بطريقة NECلكل شقه

c. كون جدول بالتوزيع المتزن لاحمال على الاوجه الثلاثةلكل شقه

d. اختارC.B والكابل العمومين للوحه الفرعيه لكل شقه

e. ارسم مخطط SLDللوحة التوزيع لكل شقة

يتم تقسيم اللوحات الفرعية على لوحتين عموميتين رئيسيتان بحيث تكون الشقق من 1 الى 27 على اللوحة الاولى والشقق من 28 الى 45 بالاضافة الى الخدمات العامة على اللوحة الثانية

f. ارسم اللوحة العمومية الاولى بالعمارة

g. كون جدول بالتوزيع المتزن لاحمال على الاوجه الثلاثة للوحتين العموميتين واختار C.Bs والكابلات العمومية لتغذية اللوحتين العموميتين

h. حدد عدد المحولات المستخدمة ومع وجود وحدات ديزل واحمال هامة جدا ارسم مخططSLD لربط هذه العمارة بشبكة التغذية العامة من خلال RMU

درجة حرارة الهواء	25	30	35	40	45	50	55
PVC	1.13	1.07	1.00	0.93	0.85	0.76	0.65
XLPE	1.09	1.04	1.00	0.95	0.90	0.85	0.80

	عدد الكابلات على الحامل				
	2	3	5-4	8-6	أكثر من 9
معامل التصحيح للمجموعات أفقية	0.85	0.78	0.75	0.72	0.7
معامل التصحيح للمجموعات الرأسية	0.8	0.73	0.7	0.86	0.66

مساحة المقطع mm^2	التيار وجه واحد بالامبير	التيار ذو ثلاثة اوجه بالامبير
1.5	17	15
2.5	23	21
4	31	28
6	40	36
10	55	50
16	74	66
25	97	88
35	120	109
50	146	131
70	185	167
95	225	202
120	260	234
150	299	269
185	341	307
240	401	360

معاملات الانعكاس										
Ceiling	0.8	0.8	0.8	0.5	0.5	0.8	0.8	0.5	0.5	0.3
Wall	0.8	0.5	0.3	0.5	0.3	0.8	0.3	0.5	0.3	0.3
Surface	0.3	0.3	0.3	0.3	0.3	0.1	0.1	0.1	0.1	0.1
Room Index Factor, k	Room Utilization Factor in %									
0.6	73	46	37	44	36	66	36	42	35	35
0.8	82	57	47	54	46	74	45	51	44	44
1.0	91	66	56	62	54	80	53	59	52	51
1.25	98	75	65	70	62	85	61	66	60	59
1.5	103	82	73	76	69	89	67	72	66	65
2.0	109	91	82	84	78	94	75	78	73	72
2.5	114	98	90	90	84	97	81	83	79	77
3.0	117	103	96	95	90	99	86	87	83	82
4.0	120	109	103	100	95	101	91	91	88	86
5.0	122	113	107	103	98	103	93	93	91	89

C.B Standard

6, 10, 15,16, 20, 25, 32, 40,50, 63,100, 125, 150,163, 200, 225, 250, 300, 400, 500, 630, 800,1000, 1200,1500,1750,2000,2200, 2500,3000,3200,4000, 5000, 6300

جدول [redacted] قيم معامل التصحيح η للإلكترودات المدفونة رأسيا

η	N	S/L	η	N	S/N	η	N	S/L
0.95 – 0.97	2	3	0.93 – 0.95	2	2	0.8 – 0.87	2	1
0.91 – 0.95	3		0.9 – 0.92	3		0.76 – 0.8	3	
0.89 – 0.92	5		0.85 – 0.88	5		0.67 – 0.72	5	
0.82 – 0.88	10		0.79 – 0.83	10		0.56 – 0.62	10	
0.79 – 0.81	20		0.74 – 0.79	20		0.5 – 0.47	20	

مع اطيب التمنيات بالتوفيق

د/ عبدالوهاب حسن

د/عبدالسلام احمد

د/سمير داود

٢٠١٨/١/١٧ ٤ حوى كهربى

Tanta University

Department: Electrical Power and Machines Engineering
Total Marks: 85 Marks

Faculty of Engineering

Course Title: Power System Protection
Date: 2017/2018

Course Code: EPM41
Allowed time: 3 hrs

Year: 4th
No. of Pages: (2)

Answer the following questions

Problem number (1) **(20 Marks)**

a) Compare the redundancy and backup concepts using in the protection system? Explain the definition of protection system reliability, dependability and security? What is the criteria by which fuses on radial feeders are judged to have good coordination?

b) Explain instants of fault for no offset, positive offset and negative offset in the fault current. If the fault current consists of AC and DC components, what is the percentage overreach of a practical instantaneous overcurrent relay in terms of relay operating time and power system constants?

c) For the power system arrangement shown in Fig. 1, complete Table 1, taking into account the operation of the circuit breakers as shown for each fault case. Please note that some of the circuit breakers that operated may have done so unnecessarily.

Case	CB that operate	CB that mal-operated	Tripped by primary protection	Tripped by back-up protection
F1	2, 3, 4, 5			
F2	21, 22, 23, 24, 27			
F3	10, 11, 17, 19			

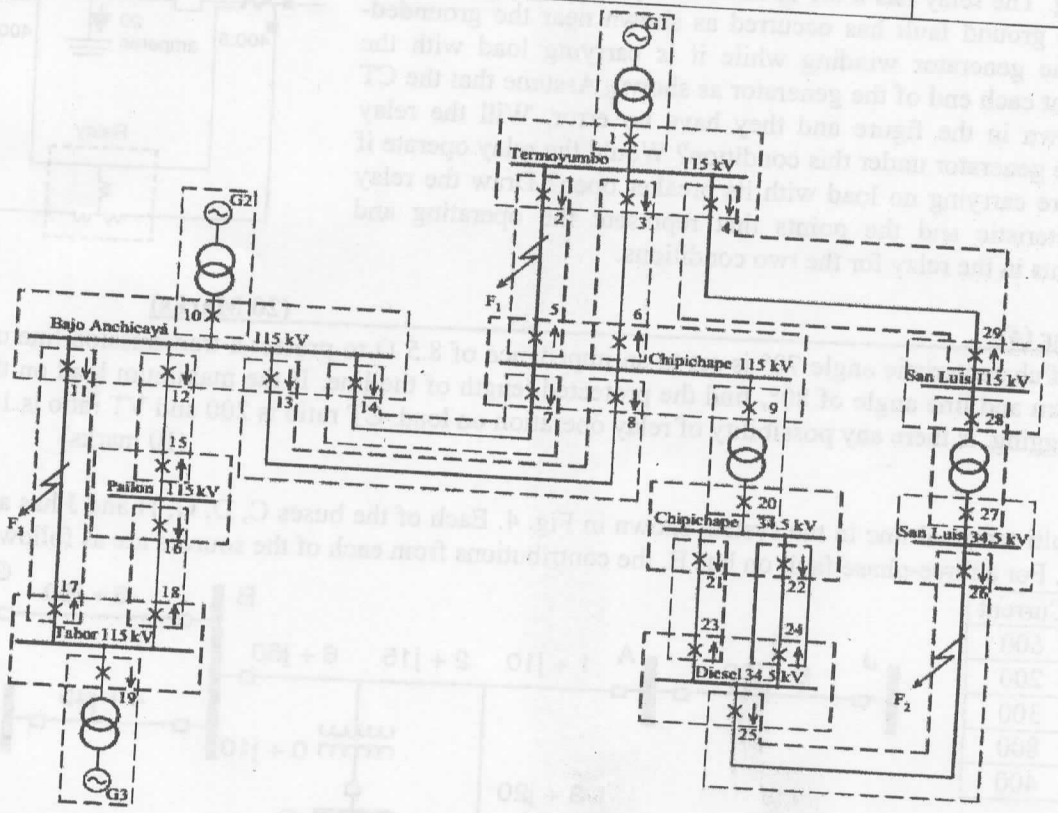


Fig. 1

Problem number (2) **(25 Marks)**

a) **Put (√) for the correct and (x) for the wrong and revise the uncorrect phrases:**

1. Protection system is designated a stable if it was sensitive for any fault within its zone.
2. Buchholz relay is one of electrical relays.
3. Attraction type relays can be used for AC and DC systems.
4. Hysterisis region is wide when the ratio between drop-out and setting values is small.
5. Coordination study is needed for unit protection.
6. Overcurrent relays represents an example for unit protection.
7. Open-circuit condition can be detected using phase current level.
8. Earth fault in isolated grounding system can be detected using current level.
9. Primary and local backup protections are recommended to be different in relaying function.
10. High set Instantaneous overcurrent relays are graded using time.

b) Simple time graded overcurrent relays are applied to a 5 bus ring main (single feed point). Circuit breakers are connected at each side of each bus. Choose time delays for each overcurrent relay and indicate which relays need to be directional. Specify the primary protection relays operating time for faults occurred in each section.

c) For the radial system shown in Fig. 2, calculate the instantaneous and IDMT relay settings at each bus. Assume the transformer is vital load and must not be de-energized if at all possible and that the relays at bus B are "looking into" a transformer differential and therefore do not coordinate with it. The characteristic of the IDMT relay is normal inverse type. The coordination margin should be selected as 0.35 s and TS or R_B is 0.1. The current in both instantaneous relays exceeds 100 A. Revise the CT ratios and recalculate both time-delay and instantaneous relay settings at bus A and B.

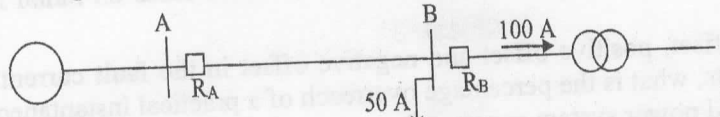


Fig. 2

Min. Fault	3000 A	2000 A	1000 A
Max. Fault	9000 A	5000 A	3000 A

Problem number (3) **(20 Marks)**

a) Describe briefly three methods used for grading the overcurrent relays in radial feeders.

b) State the relay different types according to the construction? Explain with the help of neat sketch, the construction and working of plunger type overcurrent relay.

c) Fig. 3 shows a percentage differential relay applied for the protection of a generator winding. The relay has a 0.1 A minimum pickup and a 5% slope. A high-resistance ground fault has occurred as shown near the grounded-neutral end of the generator winding while it is carrying load with the currents flowing at each end of the generator as shown. Assume that the CT ratios are as shown in the figure and they have no error. Will the relay operate to trip the generator under this condition? Would the relay operate if the generator were carrying no load with its breaker open? Draw the relay operating characteristic and the points that represent the operating and restraining currents in the relay for the two conditions.

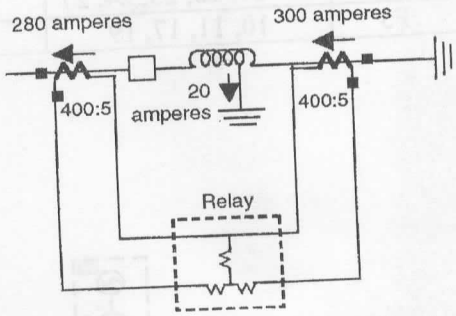


Fig. 3

Problem number (4) **(20 Marks)**

a) If a mho relay of characteristic angle 70° is set to an impedance of 8.5 Ω to protect a transmission line of 110 kV with 0.8 Ω per km and line angle of 80°, find the protected length of the line. If the maximum load on this line is 3000 A at 30° lagging, is there any possibility of relay operation on load. CT ratio is 200 and VT ratio is 1000. (10 marks)

b) Consider the multi-terminal line in the system shown in Fig. 4. Each of the buses C, D, G, H and J has a source of power behind it. For a three-phase fault on bus B, the contributions from each of the sources are as follows:

Source	Current
J	600
C	200
D	300
G	800
H	400

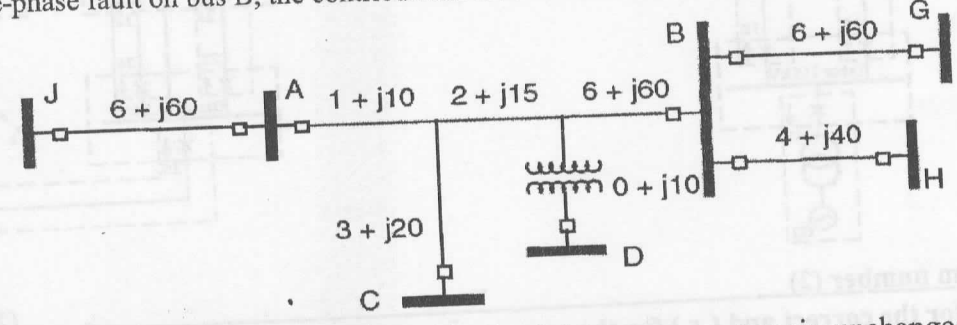


Fig. 4 →

You may assume that the fault current contributions from each of these sources remain unchanged as the fault is moved throughout the system shown. Determine the zones 1, 2 and 3 settings for the distance relays at bus C. (10 marks)

Good Luck

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