Department: **Electrical Power and Machines Engineering**

Tanta University — Total Marks: **70 Marks** — Faculty of Engineering

Course Title: **Electrical Installation** — Course Code: EPM4121 — Year: 4th
Date: Jan. 2016 (First term) — Allowed time: 3 hrs

**Answer the following questions**

**Problem number (1)** — 40 (40 Marks)

a) State the interlocks necessary to prevent accidents for isolator, circuit breaker and earthing switch. Also, State the sequence of operation of circuit-breaker, isolator and earthing switch: While opening and While closing.

b) The following table presents a load list for industrial utility:

| | Load Description | S (kVA) | pf | Vr (kV) | Duty | Criticality |
|---|---|---|---|---|---|---|
| 1 | Cooling Tower Lighting | 30 | 0.8 | 0.4 | Cont. | Normal |
| 2 | Cooling Tower HVAC | 50 | 0.8 | 0.4 | Cont. | Normal |
| 3 | Outdoor Lighting | 50 | 0.8 | 0.4 | Cont. | Normal |
| 4 | Nile Water Extraction Pump | 173 | 0.85 | 0.4 | Cont. | Normal |
| 5 | Makeup Water Treatment Pump | 10 | 0.8 | 0.4 | Cont. | Normal |
| 6 | Clarified Water Pump | 9 | 0.85 | 0.4 | Cont. | Normal |
| 7 | Fire Fighting Pump | 35 | 0.8 | 0.4 | Cont. | Normal |
| 8 | Emergency Lighting | 40 | 0.9 | 0.4 | Cont. | Essential |
| 9 | Emergency HVAC | 30 | 0.8 | 0.4 | Cont. | Essential |

Determine the operating, design and peak loads. Find the size of transformer and emergency generator. Draw the SLD with a complete information about CBs.

c) A flat consists of a reception, three rooms, two bath rooms, and kitchen with dimensions of (8 m x 8 m), (4.5 m x 4 m), (2.5 m x 3 m) and (3.25 m x 4 m). Design the lighting system required for this flat if the illumination required is 400 lx, using 60 W single fluorescent fittings having an efficiency of 60 lumens/watt. The leakage factor ($L_L$) is 0.8 and the utilization factor (UF) is 0.6. Calculate the number of sockets may be required for this flat. Draw the SLD for the panel board feeds the lighting and sockets.

d) Explain the meaning of the following expression:
   a. (3Cx240 $mm^2$ + 120 $mm^2$) Cu, PVC/PVC, AL Sheath, 0.6/1 kV.
   b. 3x(1Cx240 $mm^2$)+1Cx120 $mm^2$ AL, XLPE/PVC, 0.6/1 kV.

e) Residential building consisting of seven floors. The first floor consists of five shops each one has an electrical load of 25 kVA. The second and the third floors consist of 8 offices each. The load of each office is 15 kVA. From the fourth to the tenth floor is residential apartments 20 consumers, electrical load for each consumer 12 kVA. The building also contains two electric elevators of 15 horse power each. Assuming a diversity factor of 1.6 among the above mentioned loads:
   I. Find the total connected load and the total demand load.
   II. Determine the size of transformer required to supply this building.
   III. Draw single line diagrams (SLD) indicating all required parameters.

**Problem number (2)** — 35 (35 Marks)

a) Compare between Wenner and driven rods methods for soil resistivity measurement.

b) What do you mean by grounding of electrical networks? Explain it with an example. Describe ungrounded or isolated system and what are its disadvantages?

In 220 kV/22 kV substation the following equipment is to be connected. Draw a single line diagram of electrical scheme. Items: Four overhead 220 kV lines, Two 40 MVA, 220 kV/22 kV Transformers, One 220 kV bus coupler, Two 22 kV switchgears and Six 22 kV outgoing feeders per each switchgear. Show CTs, VTs, CBs, isolators and earthing switches where necessary. Assuming the substation is double bus single breaker.

c) A grounding system in a sandy clay soil is composed of 4 similar driven electrodes of 4.5 m long and 2.5 cm diameter, driven vertically at the shown points in Fig. 3. If the earth resistivity is 80 Ω.m, calculate the actual earth resistance and the overlapping coefficient:

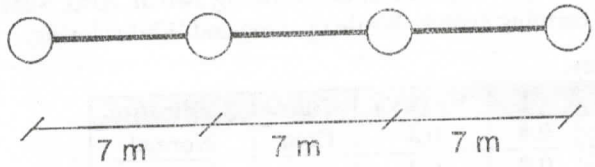


Fig. 3 (a)

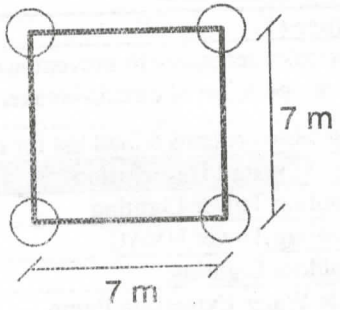


Fig. 3 (b)

You can use the following tables if you need:

**Table 1: Factors for parallel electrodes arranged in a straight line and equally spaced.**

| # of rods | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|
| λ | 1 | 1.66 | 2.15 | 2.54 | 2.87 | 3.15 | 3.39 | 3.61 | 3.81 |

**Table 2: Factors for electrodes arranged in a hollow square and equally spaced.**

| N | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 12 | 14 | 16 | 18 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| λ | 2.71 | 4.51 | 5.48 | 6.14 | 6.63 | 7.03 | 7.36 | 7.65 | 7.9 | 8.32 | 8.67 | 8.96 | 9.22 | 9.4 |

N is number of rods along each side of the square.

Note: the total number of electrodes around the square is 4(N-1).

d) Find the average soil resistivity for a site with a dimension of (70 m x 50 m) if the following resistance reading were taken for eight different points within the site:

| | 3 m | 5 m | 10 m | 20 m | 25 m |
|---|---|---|---|---|---|
| Point 1 | 0.57 Ω | 0.46 Ω | 0.18 Ω | 0.12 Ω | 0.04 Ω |
| Point 2 | 0.39 Ω | 0.33 Ω | 0.1 Ω | 0.1 Ω | 0.03 Ω |
| Point 3 | 0.13 Ω | 0.11 Ω | 0.1 Ω | 0.13 Ω | 0.03 Ω |
| Point 4 | 1.35 Ω | 0.33 Ω | 0.08 Ω | 0.15 Ω | 0.04 Ω |
| Point 5 | 0.21 Ω | 0.1 Ω | 0.09 Ω | 0.03 Ω | 0.03 Ω |
| Point 6 | 0.6 Ω | 0.4 Ω | 0.27 Ω | 0.06 Ω | 0.05 Ω |
| Point 7 | 1.36 Ω | 0.37 Ω | 0.09 Ω | 0.11 Ω | 0.03 Ω |
| Point 8 | 0.25 Ω | 0.16 Ω | 0.12 Ω | 0.07 Ω | 0.06 Ω |

Draw the resistivity versus the spacing and discuss the relation appeared. Calculate the grounding resistance for this site. Find the grounding conductor sizing considering the maximum short-circuit is 40 kA for 1 sec. Assuming only four vertical electrodes will be used. Also, assuming the spacing between horizontal conductors is 10 m.

Department: **Electrical Power and Machines Engineering**

Tanta University | Total Marks: **85 Marks** | Faculty of Engineering

Course Title: Power System Protection | Course Code: EPM4118 | Year: 4th
Date: Jan. 2016 (First term) | Allowed time: 3 hrs

**Answer the following questions aiding with a fully detailed drawing and without non-important elongation:**

**Problem number (1)** **(25 Marks)**

a) State the protection system elements? Also, State the fault detection methods?

b) Compare between unit and non-unit protection zones.

c) Give an example to show the locations of the CTs with respect to the dead and life tank circuit breakers for two overlapping unit protection.

d) Propose a schematic of basic electromechanical relays arrangement (beam type) to realize each of the distance protection function shown in Fig. 1.

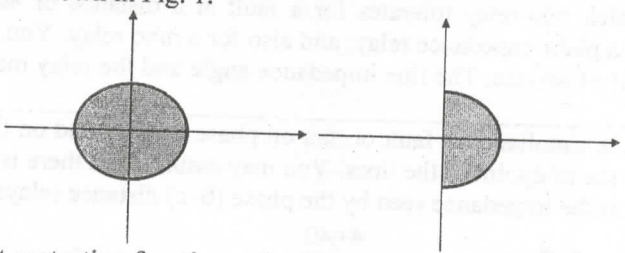

Fig. 1 Different protection functions of a distance relay, grey area is the operating area.

e) Specify the protective zones for the system shown in Fig. 2. Determine the following:

- Which zones should trip for a fault F1?
- Which zones should trip for a fault F2?
- What is the action if the primary protection for fault F1 failed to operate?

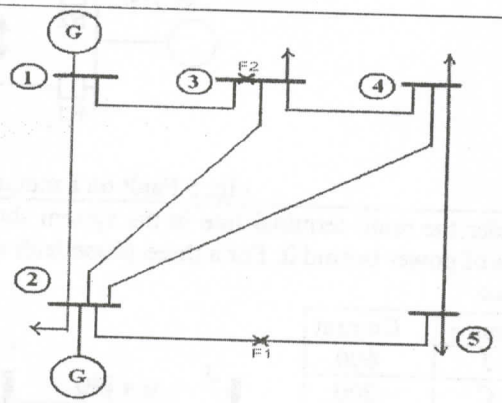


**Fig. 2**

f) Discuss the relaying system dependability and security for the network showing in Fig. 3 considering fault F.

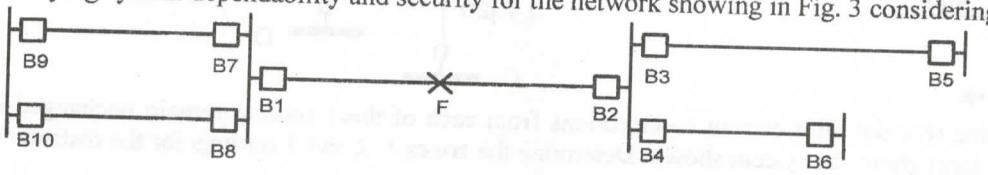


**Fig. 3**

**Problem number (2)** **(30 Marks)**

a) Aided with NET drawing, Explain CTs and VTs connections for protection system?

b) Compare between the following CT Classes: 5P20, PS, and 1M?

c) What is the overreach percentage of a practical instantaneous overcurrent relay in terms of relay operating time and power system constants?

d) If high set instantaneous overcurrent (HSIOC) relay response time is 15 msec and the voltage incident angle is 25° used to protect HVTL with $\theta = 82°$. Determine the percentage of the overreach for this relay.

**Course Examination Committee:** Dr. Mohamed Abo Elazm

e) Fig. 4 shows an 11 kV, 3-phase radial feeder is protected by two normal inverse overcurrent relays R1 and R2. Determine the turn's ratio for the two CTs, plug setting and time-dial setting of two relays, if the fault current through the feeder is 3000 Amp. Also calculate the time of operation of R1. Two relays have constants of A = 0.14 and B = 0.02.

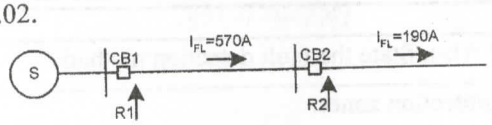


Fig. 4.

**Problem number (3)** **(30 Marks)**

a) A zone of a distance relay is set at 10 Ω secondary. The CT ratio is 500 : 5 and the VT ratio is 20000 : 69.3. What is the fault resistance which this relay tolerates for a fault at a distance of 80% of the first zone boundary? Find the answers for a plain impedance relay, and also for a mho relay. You may assume that the remote terminal of the line is out of service. The line impedance angle and the relay maximum torque angle are both equal to $80^0$.

b) For the system shown in Fig. 5, a simultaneous fault occurs on phase b to ground on line 1, and phase c to ground on line 2. The fault is at the midpoint of the lines. You may assume that there is no source connected to the far end of the lines. What is the impedance seen by the phase (b–c) distance relays of the two lines?

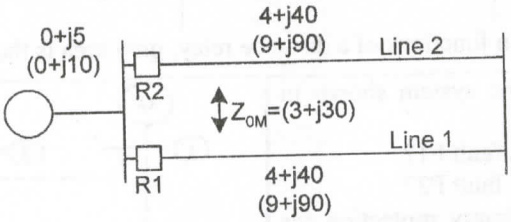


Fig. 5 Fault on a mutually coupled transmission line

c) Consider the multi-terminal line in the system shown in Fig. 6. 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 |

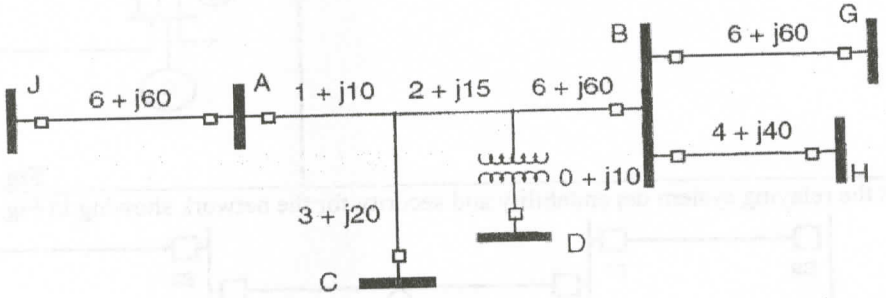


**Fig. 6 →**

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 A.

| | | |
|---|---|---|
| Tanta University | Automatic Control of Mechanical Systems | Faculty of Engineering |
| First Term Exam | 4th Year Mechanical Power Engineering | Mechanical Power Eng. Dept. |
| Time Allowed: 3hrs | Course Code: MEP4121 | January 30, 2016 |
| | Total Assessment Marks: 90 | |

***Please, answer the following questions:***

**Question (1)** **(20Marks)**

Figure 1 shows a crane hoisting a load. Although the actual system's model is highly nonlinear, if the rope is considered to be stiff with a fixed length $L$, the system can be modeled using the following four equations:

$$m_L\ddot{x}_{La} = m_L g\varphi \qquad m_T\ddot{x}_T = f_T - m_L g\varphi$$

$$x_{La} = x_T - x_L \qquad x_L = L\varphi$$

Where $m_L$ is the mass of the load, $m_T$ is the mass of the cart, $x_T$ and $x_L$ are displacements as defined in Fig. 1, $\varphi$ is the rope angle with respect to the vertical, and $f_T$ is the force applied to the cart.

a) Obtain the transfer function from cart velocity to rope angle $\Phi(s)/V_T(s)$
b) Assume that the cart is driven at a constant velocity $V_0$, obtain an expression for the resulting $\varphi(t)$. Show that under this condition, the load will sway with a frequency $\omega_0 = \sqrt{g/L}$
c) Find the transfer function from the applied force to the cart's position $X_T(s)/F_T(s)$
d) Show that if a constant force $F_0$ is applied to the cart, its velocity will increase without bound as $t \to \infty$

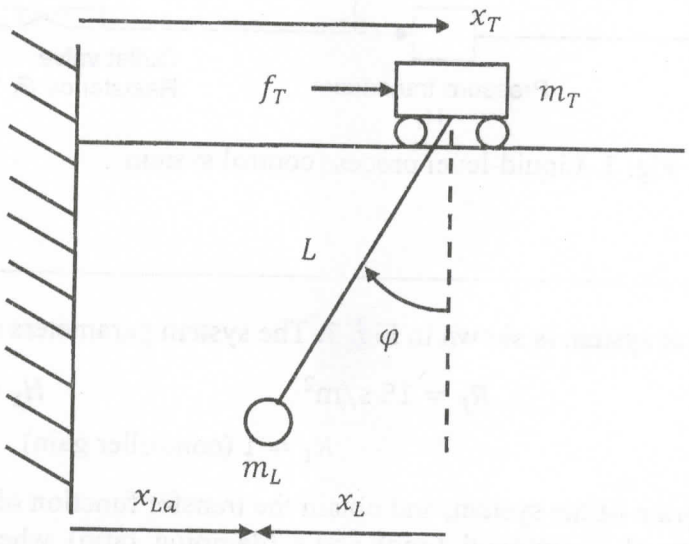


Fig. 1. A crane hoisting a load

**Question (2)** **(10Marks)**

Reduce the block diagram shown in Fig. 2 to a single block, $C(s)/R(s) = G(s)$.

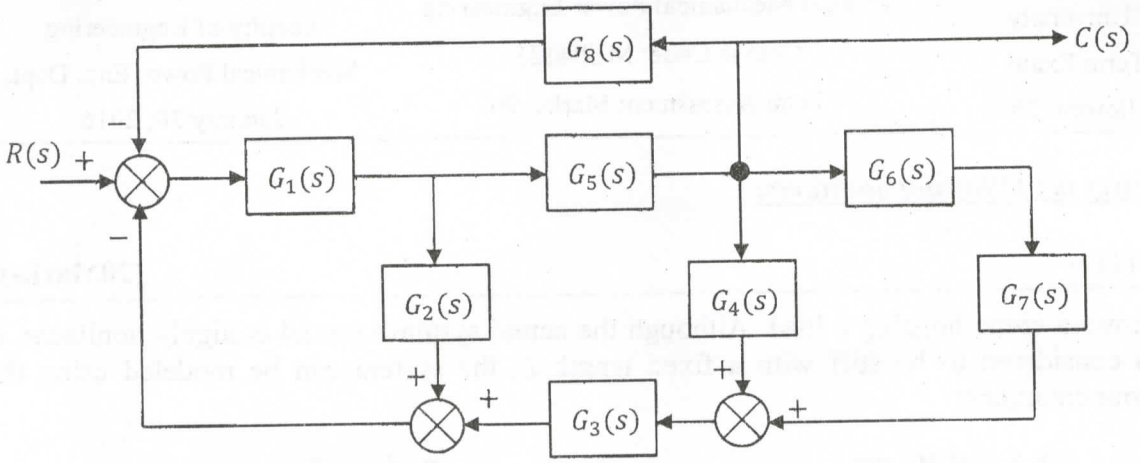


Fig. 2. Block diagram of question (2)

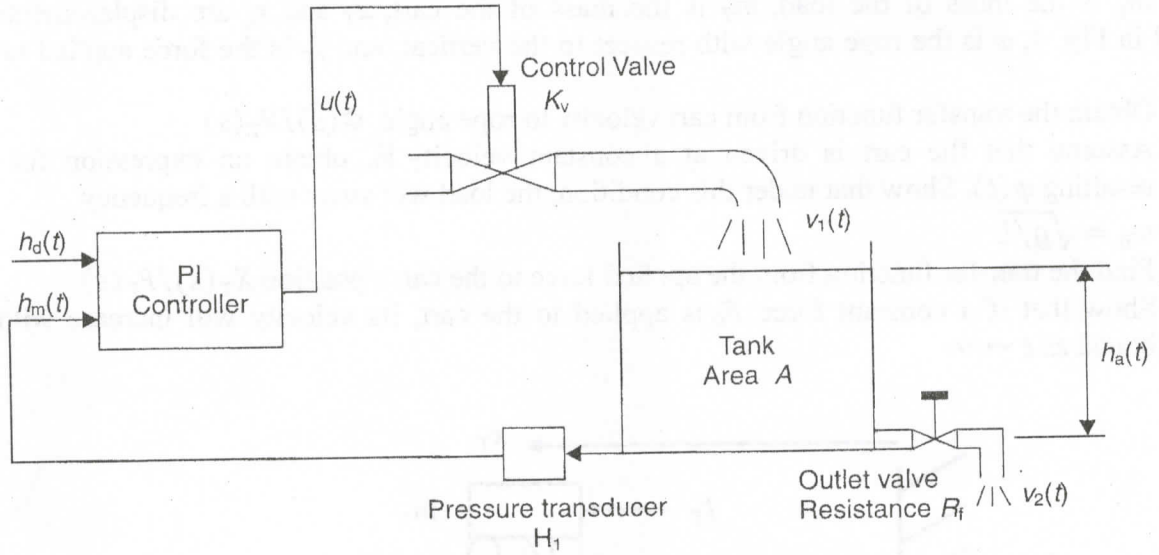


Fig. 3. Liquid-level process control system

**Question (3)** **(15Marks)**

A liquid-level process control system is shown in Fig. 3. The system parameters are:

$A = 2\ \text{m}^2$ $R_f = 15\ \text{s/m}^2$ $H_1 = 1\ \text{V/m}$

$K_V = 0.1\ \text{m}^3/\text{sV}$ $K_1 = 1$ (controller gain)

a) Draw the block diagram of the system, and obtain the transfer function of each component.
b) What are the values of $T_i$ (integral time) and $\zeta$ (damping ratio) when the undamped natural frequency of the system $\omega_n$ is 0.1 rad/s?

**Question (4)** **(15Marks)**

Assume that the motor whose transfer function is shown in Fig. 4_a is used as the forward path of a closed-loop, unity feedback system.

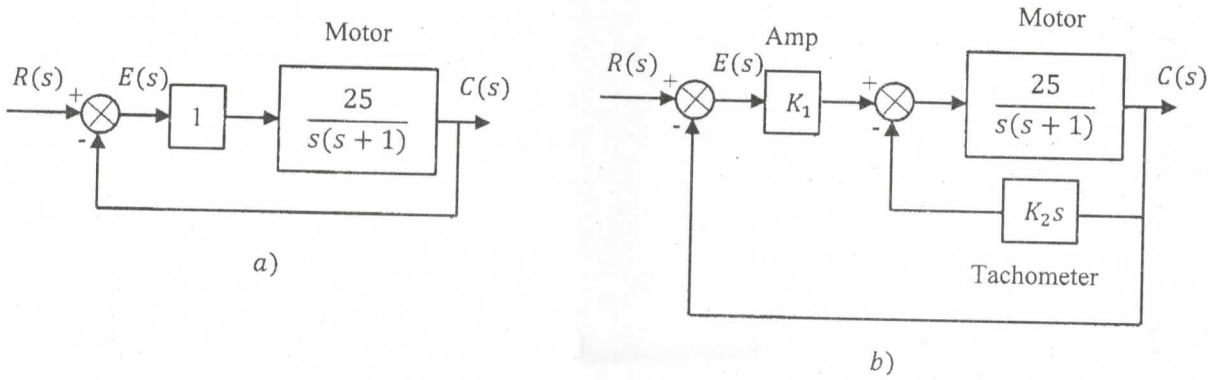


Fig. 4. a) position control, b) position control with tachometer

a) Calculate the percent overshoot and settling time that could be expected.
b) You want to improve the response found in Part (a). Since the motor and the motor constants cannot be changed, an amplifier and a tachometer (voltage generator) are inserted into the loop, as shown in Fig. 4_b. Find the values of $k_1$ and $k_2$ to yield a 16% overshoot and a settling time of 0.2 second.

**Question (5)** **(10Marks)**

Find the number of poles in the right half side of the s-plane for a unity feedback closed-loop system, which has a feed forward transfer function $G(s)$, given as:

$$G(s) = \frac{1}{s(2s^4 + 3s^3 + 2s^2 + 3s + 2)}$$

**Question (6)** **(20Marks)**

For a unity feedback system with an open-loop transfer function given as:

$$G(s)H(s) = \frac{K}{(s + 3)(s^2 + 4s + 5)}$$

a) Sketch the root locus by obtaining:
   - The asymptotes
   - The imaginary-axis crossing and the gain, $K$ , at the crossing
   - The angles of departure from the complex poles
b) Find the values of the closed-loop poles if the system is operating with 15% overshoot.

**Best of Luck**

*Dr. Omar Mehrez*