Swami Keshvanand Institute of Technology,
Management & Gramothan

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Sample Tutorial Sheets
Session: 2023-24

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18. Tutorial Sheets (with EMD Analysis)

Tutorial Sheet-1

1. What are the various CMOS fabrication techniques
2. Explain the basic steps of PMOS fabrication.
3. Derive the V-I characteristic equation (Drain current equation) for NMOS in linear and saturation modes.
4. Explain the working principal of Enhancement type nMOS transistor.
5. Discuss the aspects of threshold voltage and derive the expression for overall threshold voltage for n-channel MOSFET.
6. What is Latch – up? How it can be prevented?
7. Why NMOS technology is preferred more than PMOStechnology
8. What is substrate-bias effect or Body effect?
9. What are the advantages and disadvantages of SOI method of CMOS fabrication?
10. The drain of an n – channel MOSFET is shorted to the gate so that $V_{GS} = V_D$. The threshold voltage (V_T) of MOSFET is 1 V. If the drain current (I_D) is 1 mA for V_{GS} = 2 V, then calculate drain current for $V_{GS} = 3\ V$.

Tutorial Sheet-1 (EMD Analysis)

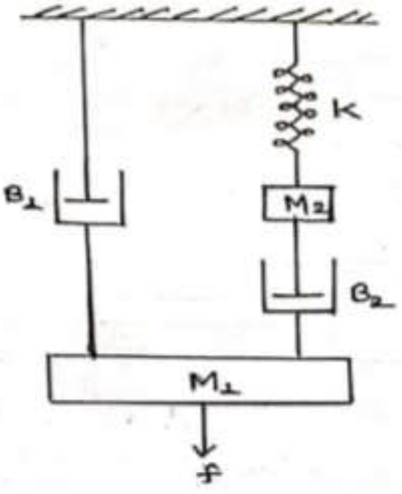
Year: II yr, Semester: III semester

Course: ELECTRONIC DEVICES(7EC5-11)

Q No.	CO	Remarks
1.	1	E
2.	1	M
3.	1	M
4.	1	E
5.	1	M
6.	1	M
7.	1	M
8.	1	E
9.	1	M
10.	1	D

**E: Easy, M: Moderate, D: Difficult

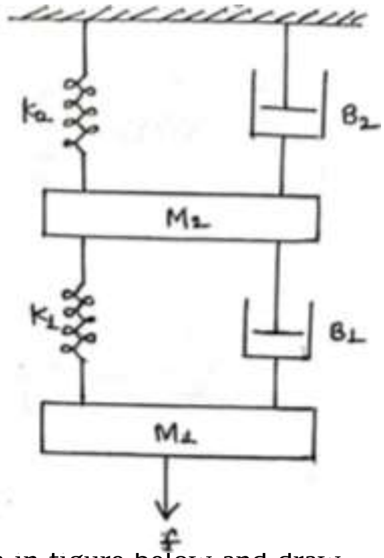
1) Write the differential equations describe in the mechanical systems shown in figure below and draw its analogues electrical networks using both analogies. **(E)**



ANS: $f = M_1\ddot{x}_1 + B_2(\dot{x}_1 - \dot{x}_2) + B_1\dot{x}_1$

$0 = M_2\ddot{x}_2 + B_2(\dot{x}_2 - \dot{x}_1) + k\,x_2$

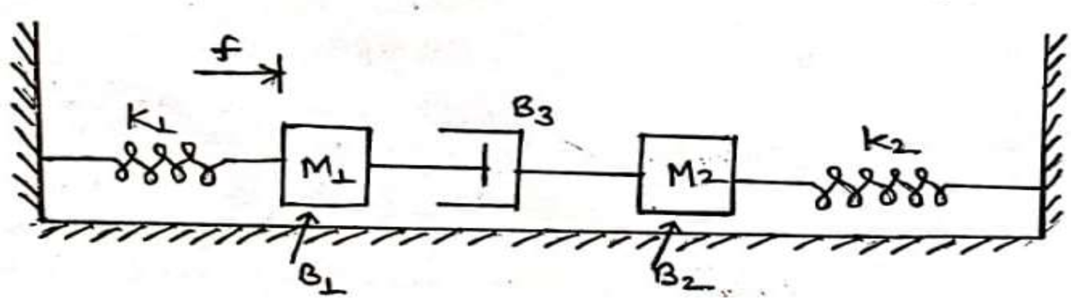
2) Write the differential equations describe in the mechanical systems shown in figure below and draw its analogues electrical network using both analogies. **(E)**



ANS: $f = M_1\ddot{x}_1 + B_2(\dot{x}_1 - \dot{x}_2) + k_1(x_1 - x_2)$

$0 = M_2\ddot{x}_2 + B_2\dot{x}_2 + B_1(\dot{x}_2 - \dot{x}_1) + k_2\,x_2 + k_1(x_2 - x_1)$

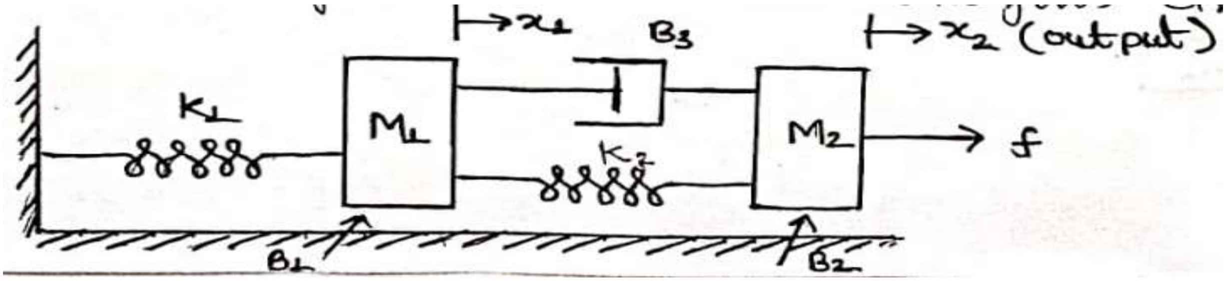
3) Write the differential equations describe in the mechanical systems shown in figure below and draw its analogues electrical network using both analogies. **(E)**



ANS: $f = M_1\ddot{x}_1 + B_1\dot{x}_1 + B_3(\dot{x}_1 - \dot{x}_2) + k_1x_1$

$0 = M_2\ddot{x}_2 + B_2\dot{x}_2 + B_3(\dot{x}_2 - \dot{x}_1) + k_2\,x_2$

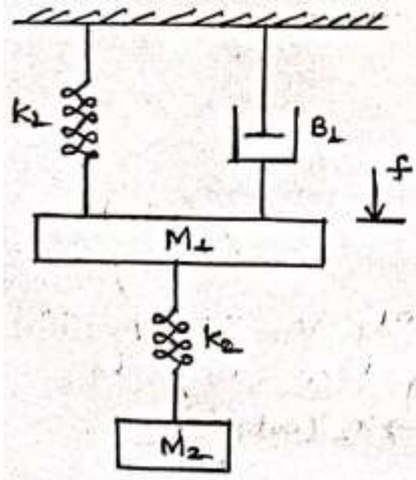
4) Write the differential equations describe in the mechanical systems shown in figure below and draw its analogues electrical network using both analogies. Also, obtain the transfer function. **(M)**



ANS: $0 = M_1\ddot{x}_1 + B_1\dot{x}_1 + B_3(\dot{x}_1 - \dot{x}_2) + k_1x_1 + k_2(x_1 - x_2)$

$f = M_2\ddot{x}_2 + B_2\dot{x}_2 + B_3(\dot{x}_2 - \dot{x}_1) + k_2(x_2 - x_1)$

5) Obtain the nodal for the mechanical system shown in figure below and draw its analogues electrical networks using both analogies. **(M)**



ANS: $f = M_1\ddot{x}_1 + B_1\dot{x}_1 + K_2(x_1 - x_2) + k_1x_1$

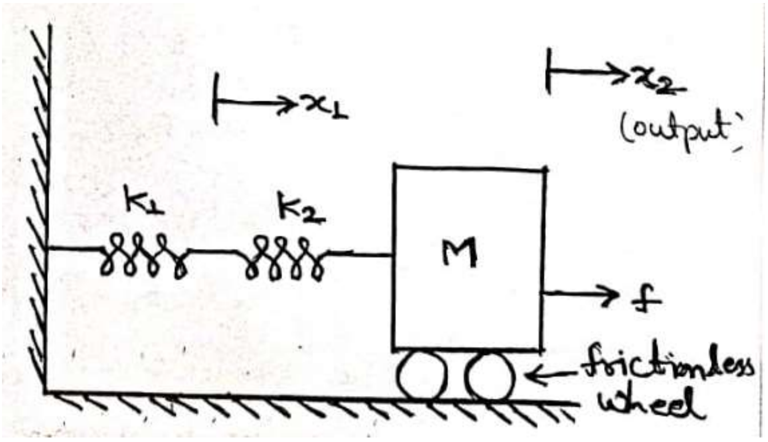
$0 = M_2\ddot{x}_2 + K_2(x_2 - x_1)$

6) Obtain the nodal equations for the mechanical system shown in figure below and draw its analogues electrical networks using both analogies and also calculate its transfer function. **(M)**

ANS: $f = M\ddot{x}_2 + K_2(x_2 - x_1)$

$0 = K_2(x_1 - x_2) + K_1x_1$

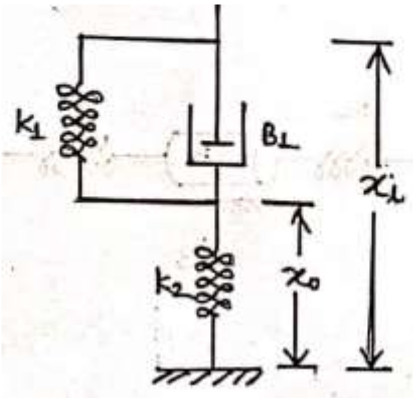
$$\frac{X_2(s)}{F(s)} = \frac{1}{Ms^2 + \frac{K_1K_2}{K_1 + K_2}}$$



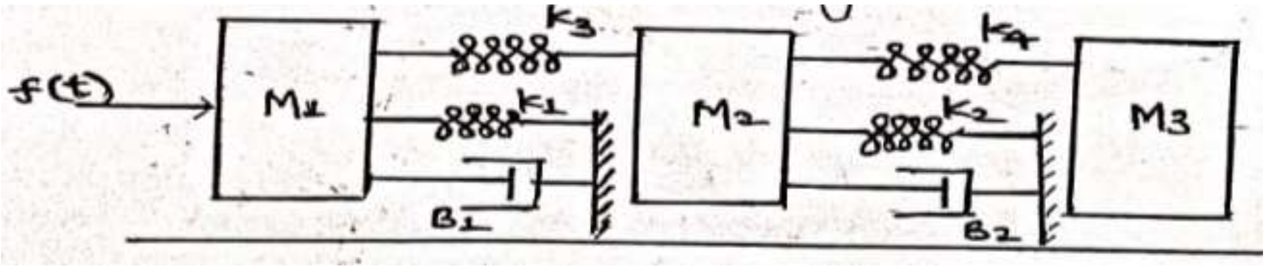
7) Write the differential equations describe in the mechanical systems shown in figure below and draw its analogues electrical network using both analogies. Also, obtain the transfer function. **(M)**

ANS:

$$\frac{X_o(s)}{X_i(s)} = \frac{sB_1 + K_1}{sB_1 + K_1 + K_2}$$



8) Write the differential equations describe in the mechanical systems shown in figure below and draw its analogues electrical network using both analogies. **(M)**

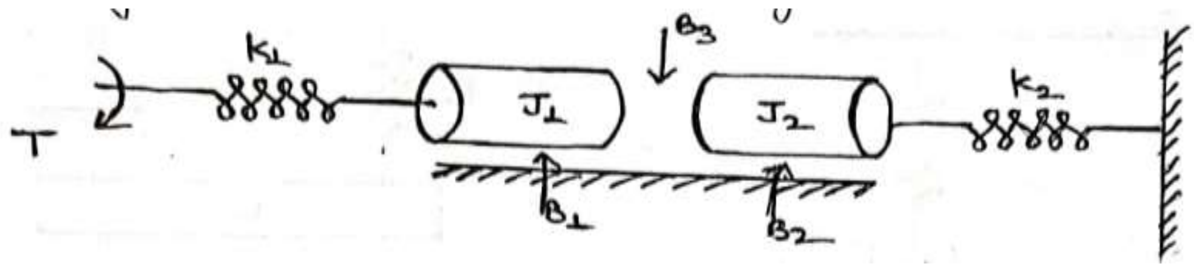


ANS: $f = M_1\ddot{x}_1 + B_1\dot{x}_1 + k_1x_1 + k_3(x_1 - x_2)$

$$0 = M_2\ddot{x}_2 + B_2\dot{x}_2 + k_2x_2 + k_3(x_2 - x_1) + k_4(x_2 - x_3)$$

$$0 = M_3\ddot{x}_3 + k_4(x_3 - x_2)$$

9) Obtain the nodal equations for the mechanical system shown in figure below and draw its analogues electrical networks using both analogies. **(D)**

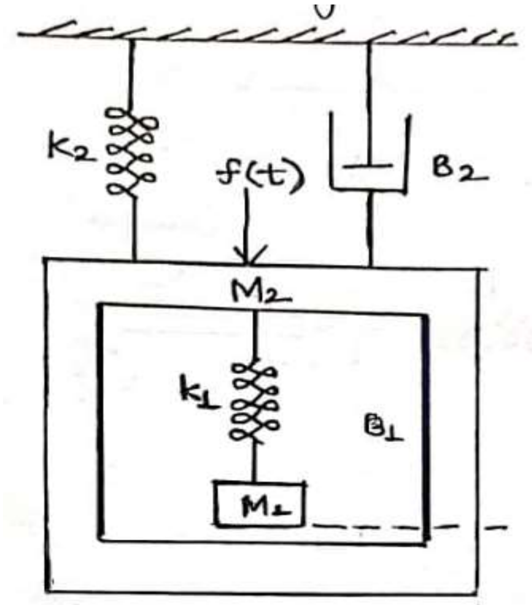


ANS: $T = K_1(\theta_1 - \theta_2)$

$$0 = J_1\ddot{\theta}_2 + B_1\dot{\theta}_2 + B_3(\dot{\theta}_2 - \dot{\theta}_3) + K_1(\theta_2 - \theta_1)$$

$$0 = J_2\ddot{\theta}_3 + B_2\dot{\theta}_3 + B_3(\dot{\theta}_3 - \dot{\theta}_2) + K_2\theta_3$$

10) Obtain the nodal equations for the mechanical system shown in figure below and draw its analogues electrical networks using both analogies. **(D)**



ANS: $0 = M_1 \ddot{x}_1 + B_1(\dot{x}_1 - \dot{x}_2) + k_1(x_1 - x_2)$

$f = M_2 \ddot{x}_2 + B_2\dot{x}_2 + B_1(\dot{x}_2 - \dot{x}_1) + k_2x_2 + k_1(x_2 - x_1)$

Tutorial Sheet-1

Q.1. Determine Y_{bus} for the five-bus system shown in fig (1). Assume that the lines shown dotted are not connected and the shunt admittance at the buses and mutual couplings between the lines are neglected. (M)

Solution:-

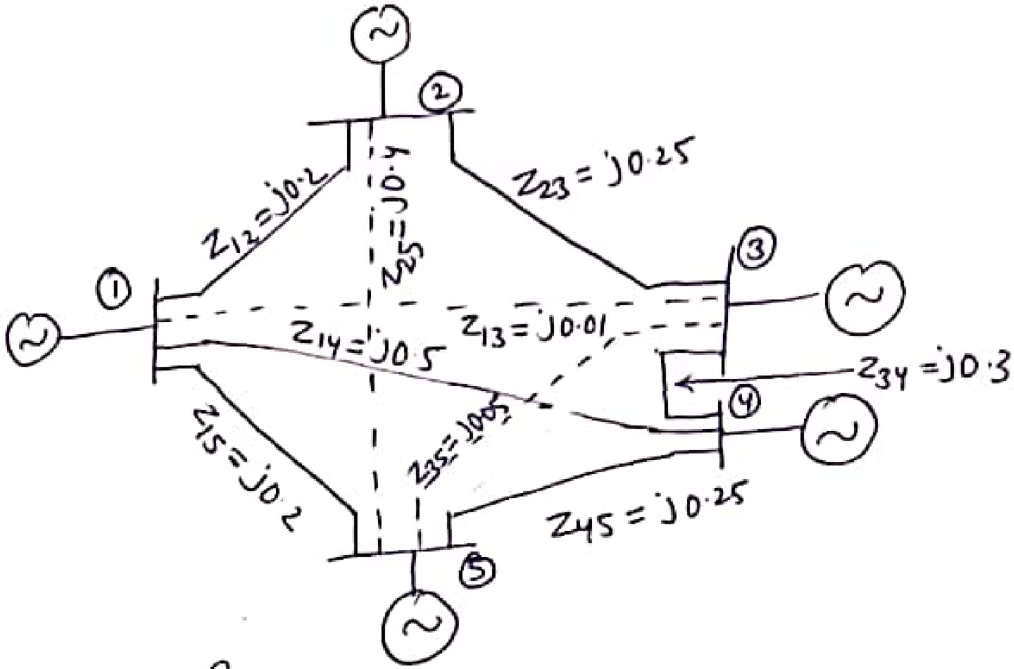


fig (1)

$y_{12} = -j5$; $y_{23} = -j4$; $y_{15} = -j5$; $y_{45} = -j4$; $y_{34} = -j3.33$

$y_{14} = -j2$

$Y_{11} = y_{12} + y_{15} + y_{14} = -j5 - j5 - j2 = -j12$

$Y_{22} = y_{12} + y_{23} = -j9$; $Y_{33} = y_{23} + y_{34} = -j4 - j3.33 = -j7.33$

$Y_{44} = y_{34} + y_{14} + y_{45} = -j3.33 - j2 - j4 = -j9.33$

$Y_{55} = y_{15} + y_{45} = -j5 - j4 = -j9$

$Y_{12} = j5$, $Y_{14} = j2$; $Y_{15} = j5$; $Y_{23} = j4$; $Y_{34} = j3.33$

$Y_{45} = j4$

$$Y_{bus} = \begin{bmatrix} Y_{11} & Y_{12} & Y_{13} & Y_{14} & Y_{15} \\ Y_{21} & Y_{22} & Y_{23} & Y_{24} & Y_{25} \\ Y_{31} & Y_{32} & Y_{33} & Y_{34} & Y_{35} \\ Y_{41} & Y_{42} & Y_{43} & Y_{44} & Y_{45} \\ Y_{51} & Y_{52} & Y_{53} & Y_{54} & Y_{55} \end{bmatrix} = \begin{bmatrix} -j12 & j5 & 0 & j2 & j5 \\ j5 & -j9 & j4 & 0 & 0 \\ 0 & j4 & -j7.33 & j3.33 & 0 \\ j2 & 0 & j3.33 & -j9.33 & j4 \\ j5 & 0 & 0 & j4 & -j9 \end{bmatrix}$$

imp

Q(2) In Example (1), if the line between buses 2 and 5 with an impedance j0·4 is connected, determine the modified bus admittance matrix. The other lines shown dotted are not connected. (E)

Sol:- By addition of one new line between buses 2 and 5, only four elements namely Y_{22}, Y_{55}, Y_{25}, Y_{52} are modified.

$$y_{25} = \frac{1}{Z_{25}} = \frac{1}{j0.4} = -j2.5$$

$$Y_{22}(new) = Y_{22}(old) + y_{25} = -j9 - j2.5 = -j11.5$$

$$Y_{55}(new) = Y_{55}(old) + y_{25} = -j9 - j2.5 = -j11.5$$

$$Y_{52} = Y_{25} = j2.5$$

Therefore, the modified bus admittance matrix is given by

$$Y_{bus} = \begin{bmatrix} -j12 & j5 & 0 & j2 & j5 \\ j5 & -j11.5 & j4 & 0 & j2.5 \\ 0 & j4 & -j7.33 & j3.33 & 0 \\ j2 & 0 & j3.33 & -j9.33 & j4 \\ j5 & j2.5 & 0 & j4 & -j11.5 \end{bmatrix}$$

Q.3. Determine Y_{bus} for the 4-bus system shown in fig. The line series impedances are as follows

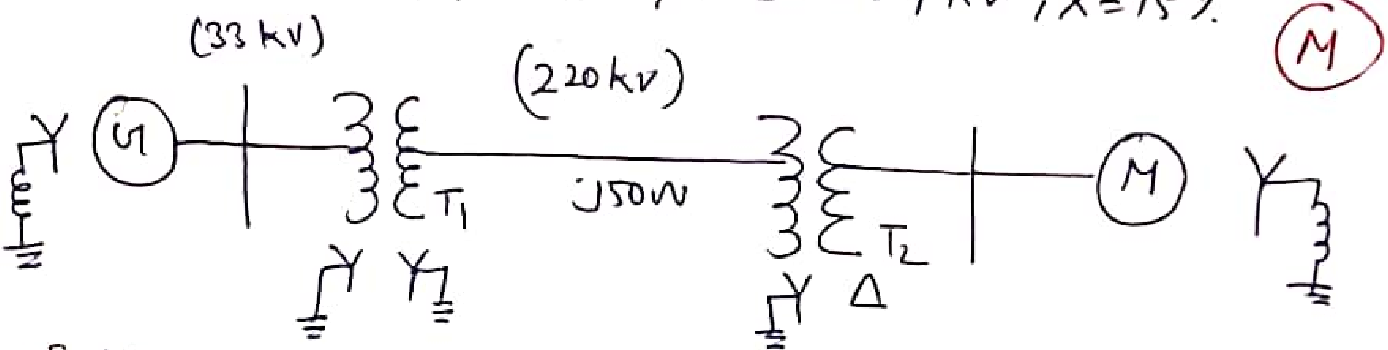
Line (bus to bus)	Impedance (PU)
1-2	0.25+j1
1-3	0.20+j0.8
1-4	0.30+j1.2
2-3	0.20+j0.8
3-4	0.15+j0.6

Each line b/w buses, 1-2, 1-3 and 1-4 has a total shunt admittance of -j0.16 PU. Determine the bus admittance matrix. (D)

$$Y_{bus} = \begin{bmatrix} 5-j20 & -1.66+j5 & -3.33+j10 \\ -1.66+j5 & 2.91-j13.5 & -1.25+j3.75 \\ -3.33+j10 & -1.25+j3.75 & 4.58-j18.75 \end{bmatrix}$$

Q.3 Draw the pu impedance diagram for the power system shown in fig. Neglect resistance, and use a base of 100 MVA, 220 kV in 50 Ω line. The ratings of the generator, motor and transformers are:

Generator 40 MVA, 25 kV, $X'' = 20\%$.
Motor 50 MVA, 11 kV, $X'' = 30\%$
Y-Y transformer, 40 MVA, 33 Y - 220 Y kV, $X = 15\%$
Y-Δ transformer, 30 MVA, 11 Δ - 220 Y kV, $X = 15\%$



Soln:-

$V_{B1} = 220\,kV$; $S_B = 100\,MVA$ (Base value in X-line)

$V_{B2} = 220 \times \frac{33}{220} = 33\,kV$ (Generator)

$V_{B3} = 220 \times \frac{11}{220} = 11\,kV$ (Motor)

G: $0.2 \times \left(\frac{25}{33}\right)^2 \times \frac{100}{40} = 0.287$

T_1: $0.15 \times \left(\frac{220}{220}\right)^2 \times \frac{100}{40} = 0.375$

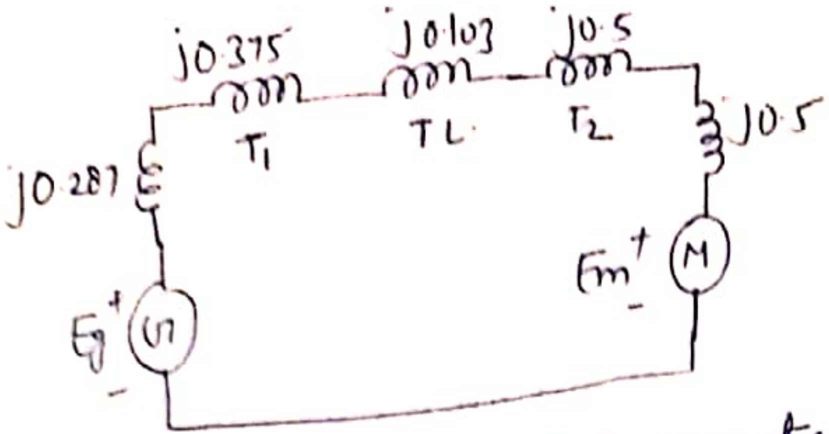
T_2: $0.15 \times \left(\frac{220}{220}\right)^2 \times \frac{100}{30} = 0.5$

M: $0.3 \times \left(\frac{11}{11}\right)^2 \times \frac{100}{50} = 0.6$

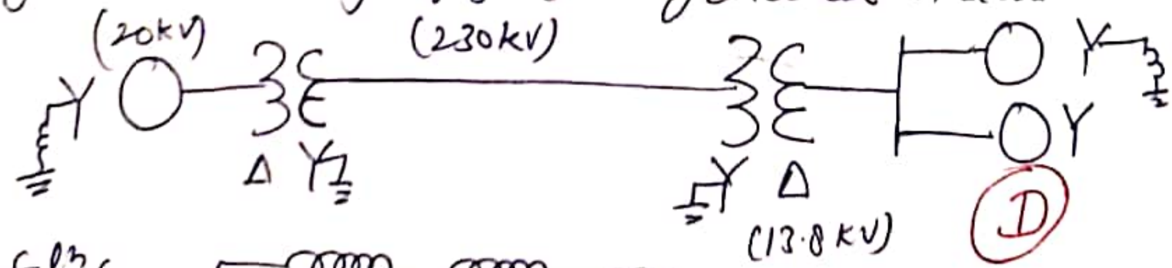
T.L: $Z_B = \frac{(220)^2}{100} = 484$

$Z_{PU} = \frac{50}{484} = j0.103$

Imp



Q.4. A 300 MVA, 20kV 3-ϕ generator has a subtransient reactance of 20%. The generator supplies a number of synchronous motors over a 64 km transmission line having transformer at both ends, as shown on the one-line diagram of fig. The motors all rated 13.2kV, are represented by just two equivalent motors. The neutral of one motor M_1 is grounded through reactance. Rated inputs to the motors are 200 MVA and 100 MVA for M_1 and M_2, respectively. For both motors $X'' = 20\%$. The 3-ϕ transformer T_1 is rated 350 MVA, 230/20 kV with leakage reactance of 10%. Transformer T_1 is composed of three single phase transformers each rated 127/13.2kV 100 MVA with leakage reactance of 10%. Series reactance of the transmission line is 0.5 Ω/km. Draw the reactance diagram with all reactances marked in pu. Select the generator rating as base in generator circuit.



Soln: