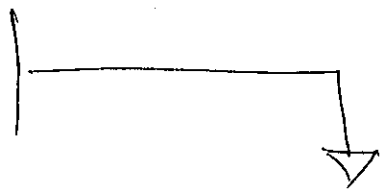Consider the load modeling problem.

$$P_{Li} = P_{Li}^S + P_{Li}^D \quad ; \ 100 \ mw$$

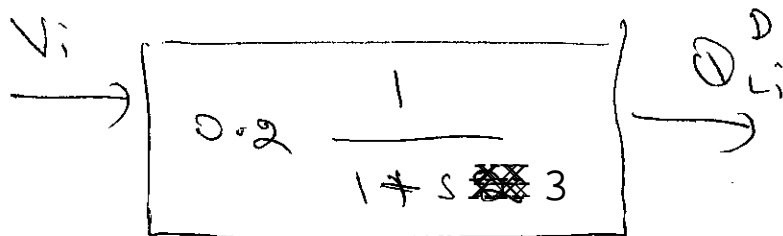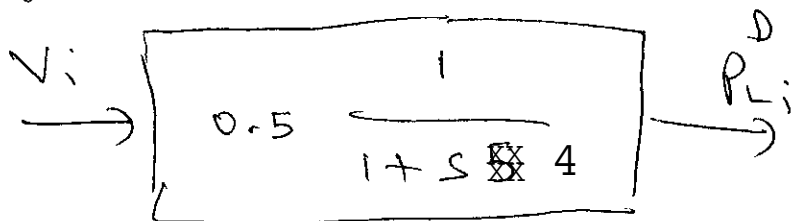$$Q_{Li} = Q_{Li}^S + Q_{Li}^D \quad ; \ 50 \ mVAR$$

Static Load Model:

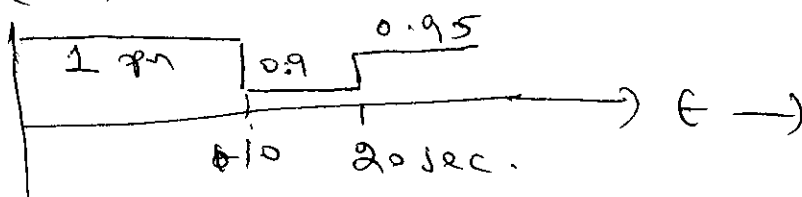$$P_{Li}^S = 0.5 \, V_i^{0.75}$$

$$Q_{Li}^S = 0.8 \, V_i^{0.65}$$

Dynamic Load Model:

$$V_i \rightarrow \boxed{0.5 \ \frac{1}{1 + s \, 4}} \rightarrow P_{Li}^D$$
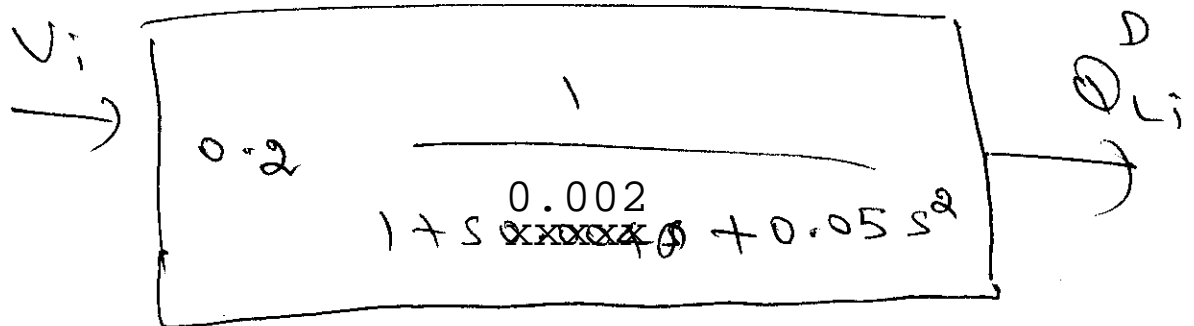
$$V_i \rightarrow \boxed{0.2 \ \frac{1}{1 + s \, 3}} \rightarrow Q_{Li}^D$$
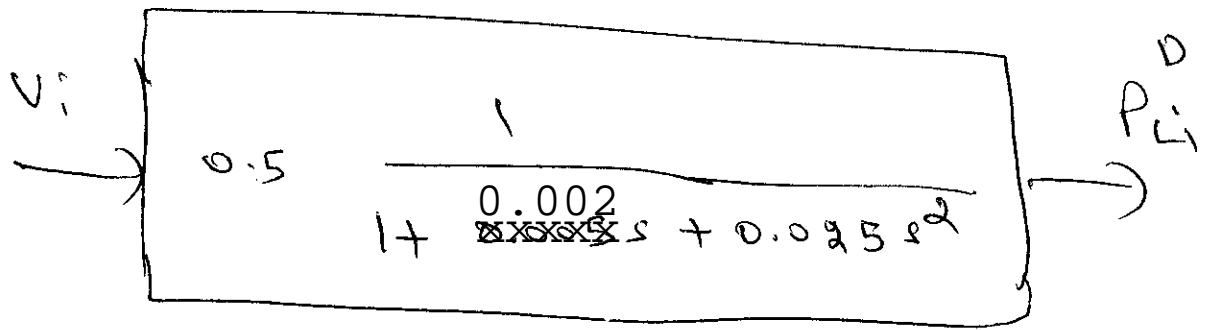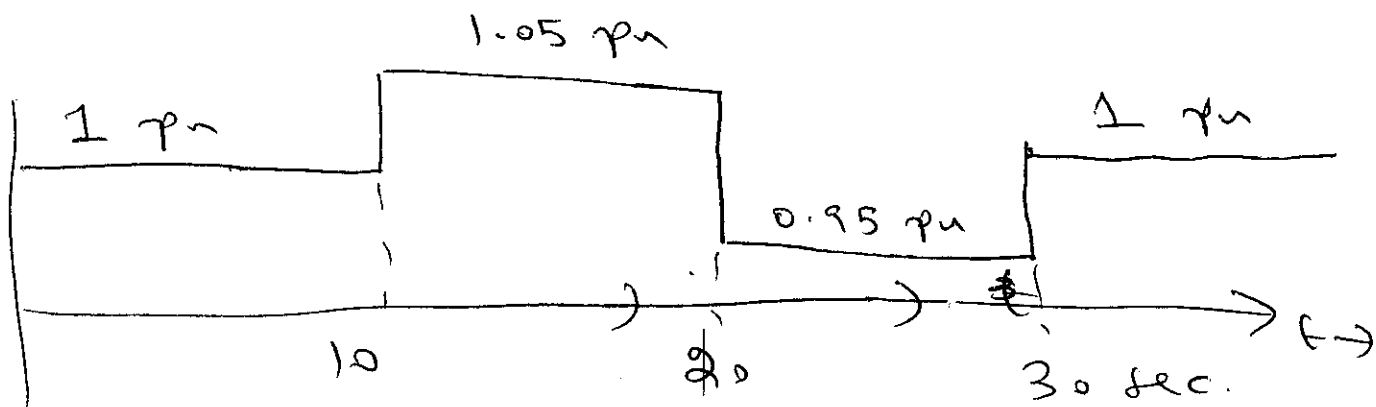
a) Suppose buss voltage changes from 1 to 0.9 pu at time $t=10$ sec. and from 0.9 pu to 0.95 pu at $t=20$ sec. Find the responses of the loads P_{Li} and Q_{Li}.

$$
\begin{array}{c}
\underline{1 \ pu} \quad 0.9 \quad \overline{0.95} \\
\hspace{2cm} \xrightarrow{\hspace{1cm}} t \longrightarrow \\
0 \ 10 \quad 20 \ \text{sec.}
\end{array}
$$

b) Repeat for the dynamic load models

V_i →
$$0.5 \quad \frac{1}{1 + 0.002\,s + 0.025\,s^2}$$
→ P_{Li}^D

V_i →
$$0.2 \quad \frac{1}{1 + s\,0.002 + 0.05\,s^2}$$
→ Q_{Li}^D

c) Repeat parts a) and b) for the voltage variation shown below:

1.05 pu

1 pu

1 pu

0.95 pu

10   20   30 sec. $t \rightarrow$

d) Suppose the static load model changes to PLStatic = 0.2 + 0.2 V + 0.1 V*V and
QLStatic = 0.1 V + 0.1 V*V. Then repeat parts a) through c) with this model.

2) Estimate the composite load model of a substation using the load response shown below. The static load is assumed to be a ZIP model and the dynamic load is modeled by a first order transfer function. (20 points)

Bus Voltage

Real power PL

0.842

0.912

0.792

1.012

Reactive power QL

0.290

0.290

0.270

0.330