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MATRIC NO: 15/ENG04/005

EEE 554 Assignment 3

Solution

a) Contingency planning entails the itemisation of actions to be taken to bring into balance supply-demand equation

b) i) Regulating Transformers
ii) Excitation Control
iii) Line reactance compensators
iv) Reactive power sinks or sources.

c) Steady state stability limit is the maximum power that can be transmitted to the receiving end without loss of synchronism.

d) i) Increasing system voltage
ii) Reduction in transfer reactance.

e) Pre-fault

$$X_I = \left[0.28 + \frac{0.16+0.24+0.16}{2} + 0.16\right]$$

$$= 0.72 \text{ pu}$$

$$P_{eI} = \frac{|E| \cdot V}{X_I} \sin\delta = \frac{1.25 \times 1}{0.72} \sin\delta$$

$$1 = 1.736 \sin\delta_0$$

$$\delta_0 = \sin^{-1}\left(\frac{1}{1.736}\right)$$

$$= 35.2^\circ = 0.62 \text{ rad}$$

During fault: Since fault occurs at one end of the line

$$P_{eII} = 0$$

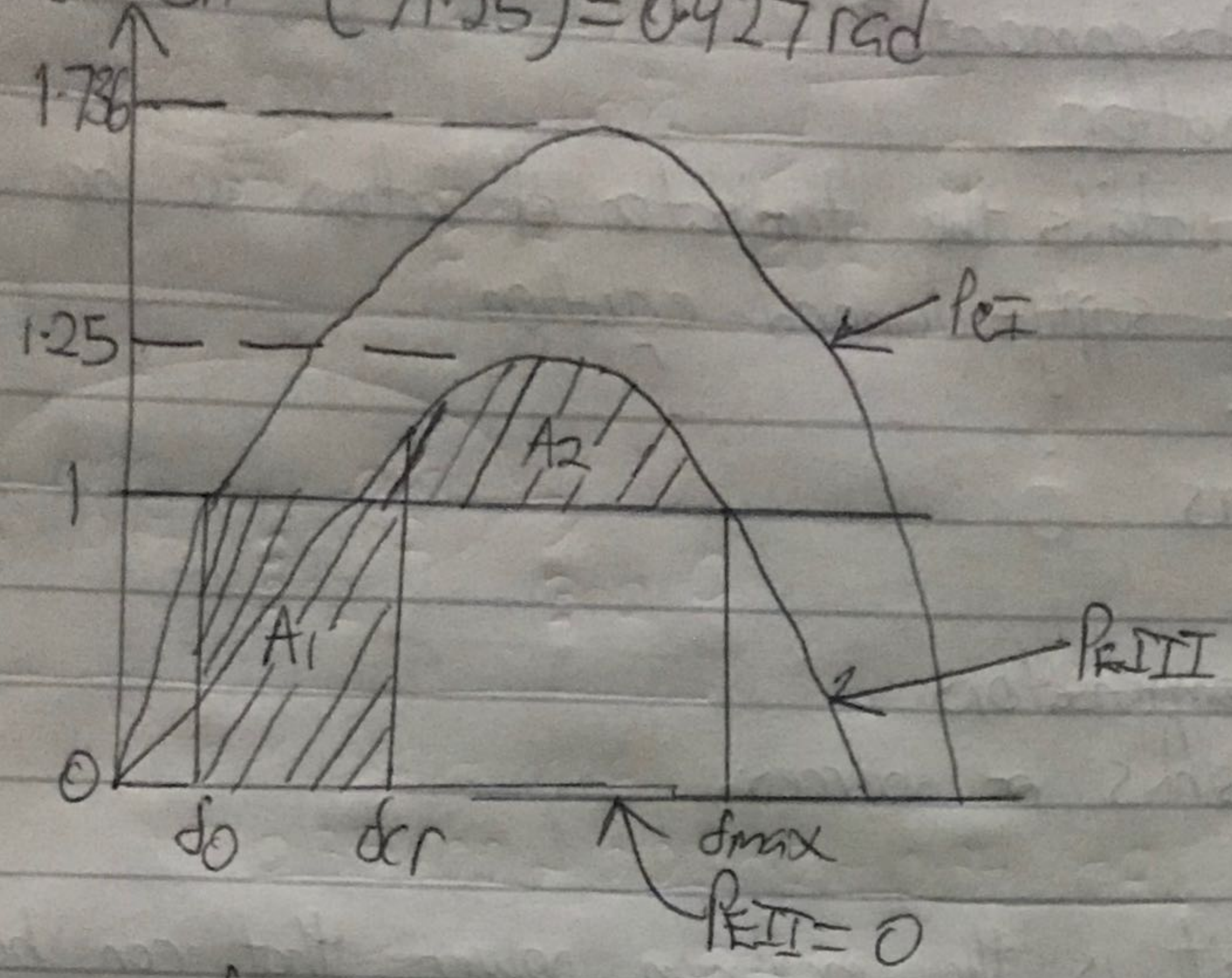
Post fault

$$X_{III} = 0.28 + 0.16 + 0.24 + 0.16 + 0.16 = 1.0 \text{pu}$$

$$P_{eIII} = \frac{1.25 \times 1}{1} \sin\delta$$

$1 = 1.25\sin\delta$

$\delta = \sin^{-1}(1/1.25) = 0.927\,rad$



δ_{max} for $A_1 = A_2$ is given by

$\delta_{max} = \pi - \delta_0 = \pi - 0.927$

$= 2.21\,rad$

$P_m = P_{max}\sin\delta_0$

$A_1 = P_m(\delta_{cr} - \delta_0) = 1(\delta_{cr} - 0.62)$

$A_1 = \delta_{cr} - 0.62$

$A_2 = \int_{\delta_{cr}}^{\delta_{max}} (P_{eIII} - P_m)\,d\delta = \int_{\delta_{cr}}^{\delta_{max}} (1.25\sin\delta - 1)\,d\delta$

$= \int_{\delta_{cr}}^{\delta_{max}} 1.25\sin\delta\,d\delta - \int_{\delta_{cr}}^{\delta_{max}} 1\,d\delta$

$= 1.25[-\cos\delta]_{\delta_{cr}}^{\delta_{max}} - [\delta]_{\delta_{cr}}^{\delta_{max}}$

$= -1.25\cos(\delta_{max} - \delta_{cr}) - (\delta_{max} - \delta_{cr})$

$= -1.25\cos(2.21) + 1.25\cos\delta_{cr} - 2.21 + \delta_{cr}$

$= 0.7457 + 1.25\cos\delta_{cr} - 2.21 + \delta_{cr}$

$= 1.25\cos + \delta_{cr} - 1.464$

$A_1 = A_2$

$\delta_{cr} - 0.62 = 1.25\cos\delta_{cr} + \delta_{cr} - 1.464$

$\cos\delta_{cr} = \frac{0.844}{1.25}$

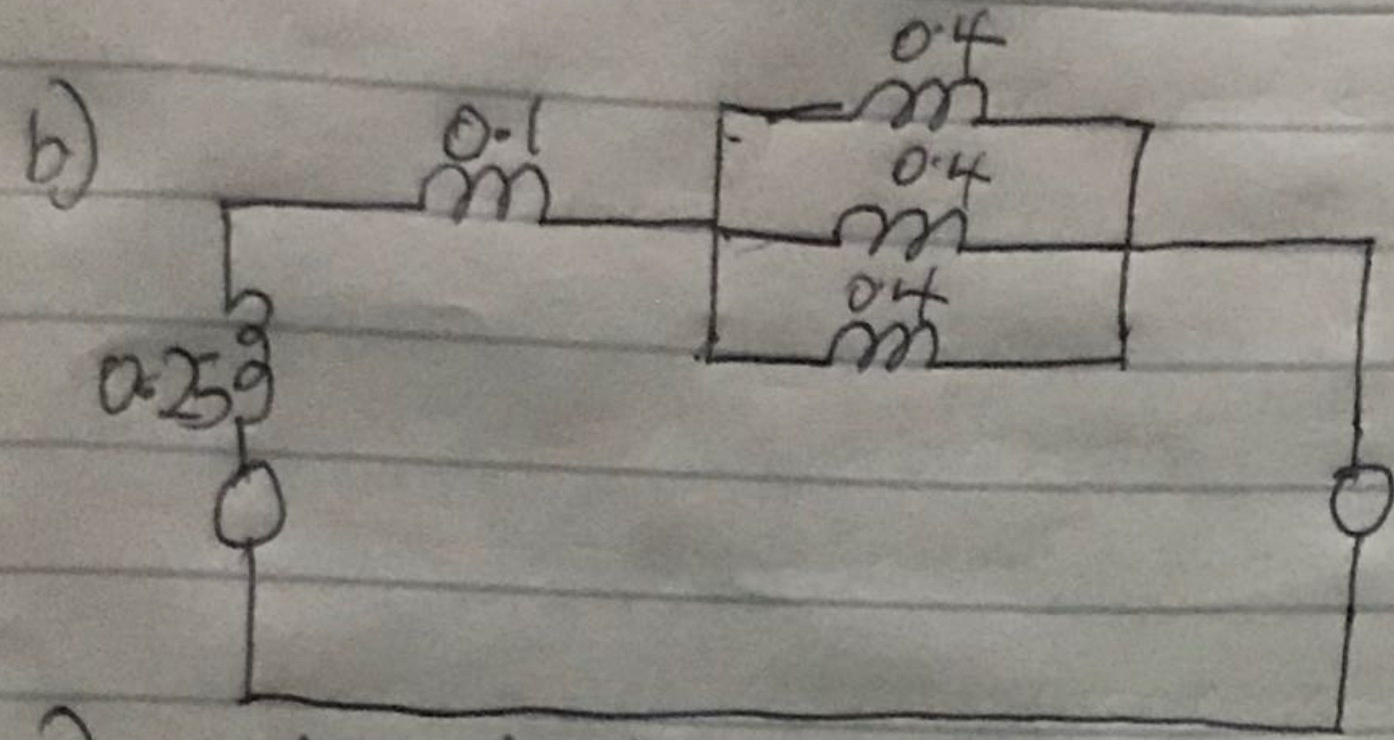
$\delta_{cr} = \cos^{-1}\left(\frac{0.844}{1.25}\right)$

$= 47.53^{\circ}$ or $0.8296\,rad$

Question 2

2c) i) Steady state
ii) Dynamic
iii) Transient

b)



i) $V_t = |V_t| \angle \alpha = 1\angle\alpha$

$P_e = \frac{|V_t||V|}{X} \sin\alpha$

$1 = \frac{|X|}{(0.25+0.1)} \sin\alpha$

$\sin\alpha = 0.0.35$

$\alpha = \sin^{-1}(0.35) = 20.5°$

Current into infinite bus

$I = \frac{|V_t|\angle\alpha - |V|\angle 0}{X}$

$= \frac{1\angle 20.5 - 1\angle 0}{j0.35}$

Recall, $A\angle\theta = A(\cos\theta + j\sin\theta)$

$I = \frac{1[\cos 20.5 + j\sin 20.5] - 1}{j0.35}$

$= \frac{-0.0633 + j0.350}{j0.35} = 1 + j0.18$

$= 1.016 \angle 10.21°$

Emf behind transient X

$E' = |V|\angle 0 + IX$

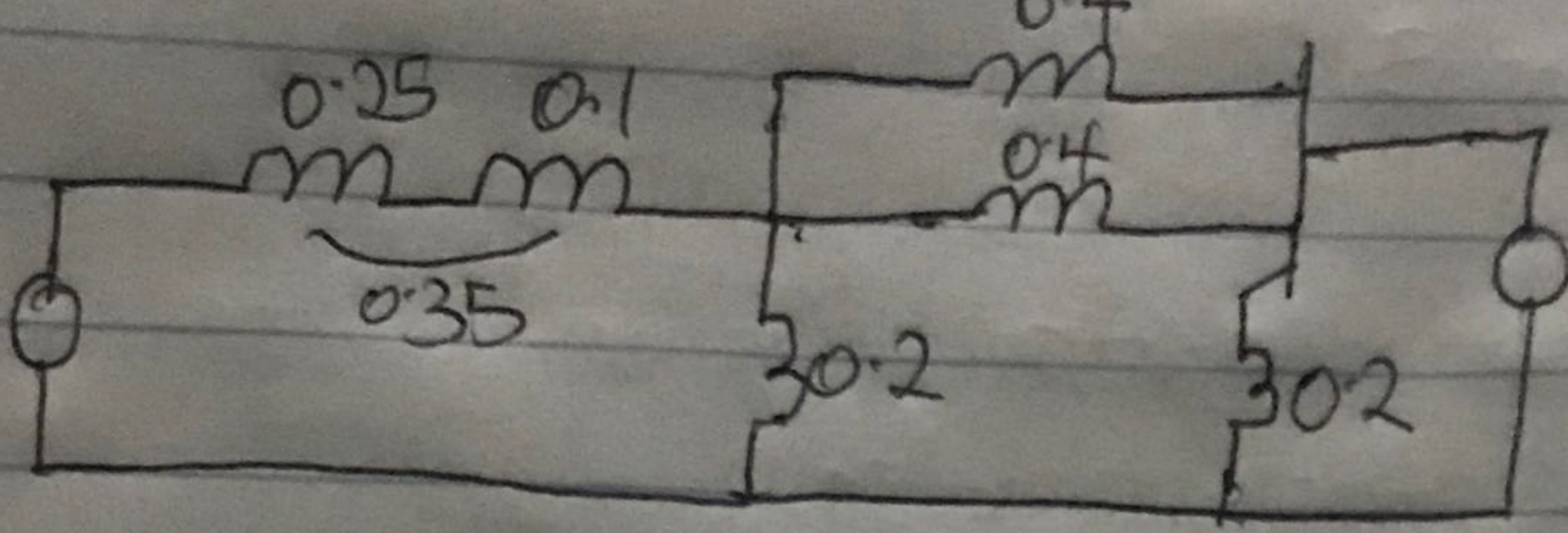
$X = 0.25 + 0.1 + 0.4/3 = j0.483$

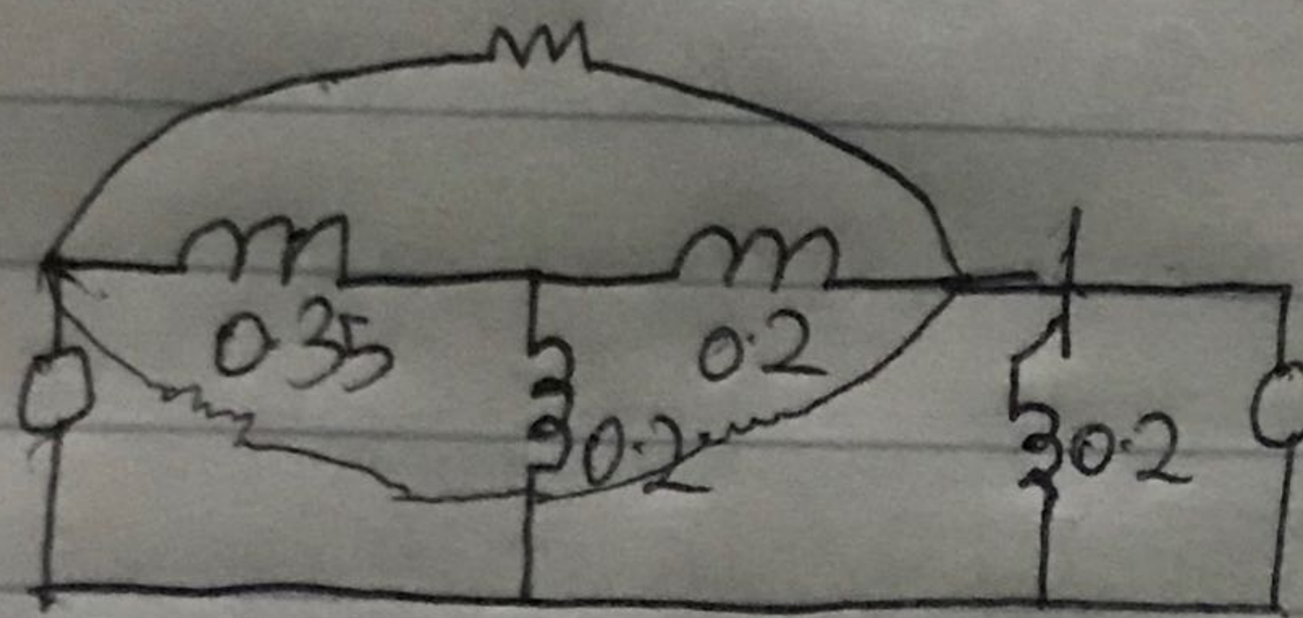
$E' = 1\angle 0 + j0.483(1 + j0.18)$

$= 1 - 0.08694 + j0.483 = 0.9131 + j0.483$

$= 1.033 \angle 27.88°$

ii) when one line is shorted





Using Star–Delta

$$X = \frac{0.35\times0.2 + 0.2\times0.2 + 0.35\times0.2}{0.2}$$

$$= 0.9$$

$$P_e = \frac{|E|.V}{X}\sin\delta = \frac{1.033\times1}{0.9}\sin\delta$$

$$= 1.148\sin\delta$$

$$P_{max} = 1.148\ pu$$