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MATRIC NO: 15/ENG04/053
COURSE CODE: EEE 554

1

a Contigency planning deals with the itemisation of actions to be taken for the supply-demand equation to be balanced.

b methods of voltage control
- Regulating transformers
- Reactive power sinks or sources
- Excitation contros
- Line reactance compensators

c The steady stability limit of a power system is the maximum power that can be transmitted to the receiving end without loss of sychronism.

d methods of improving transient stability
- Use of High speed circuit breaker
- Increasing the system voltage

e

$$P_{max} = \frac{EV}{X}$$

$$P_e = P_{max} \sin\delta$$

Prefault condition

$$X_1 = j\left[0.28 + \frac{0.16 + 0.24 + 0.16}{2} + 0.16\right]$$

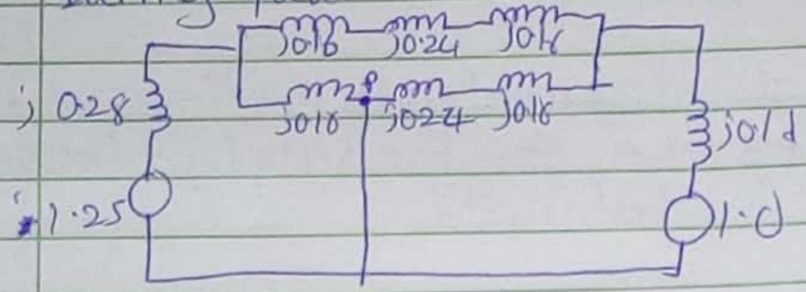
$$= 0.72pu$$

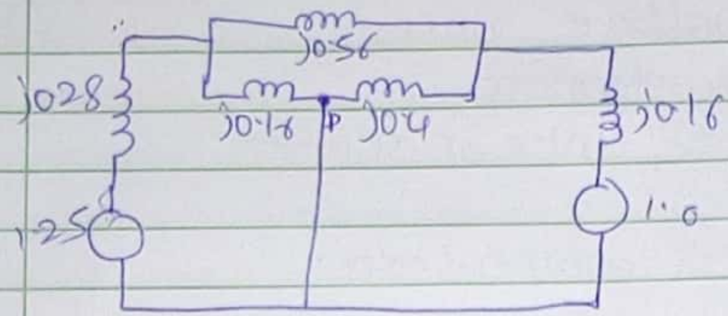
Scanned with CamScanner

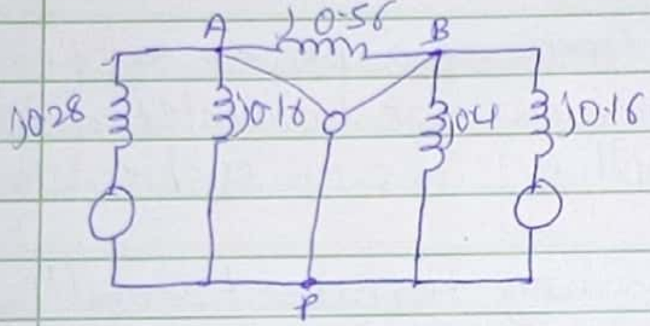
$$P_{max_1} = \frac{1.25 \times 1}{0.22} = 1.236$$

$$P_e = 1.236 \sin \delta$$

During fault.





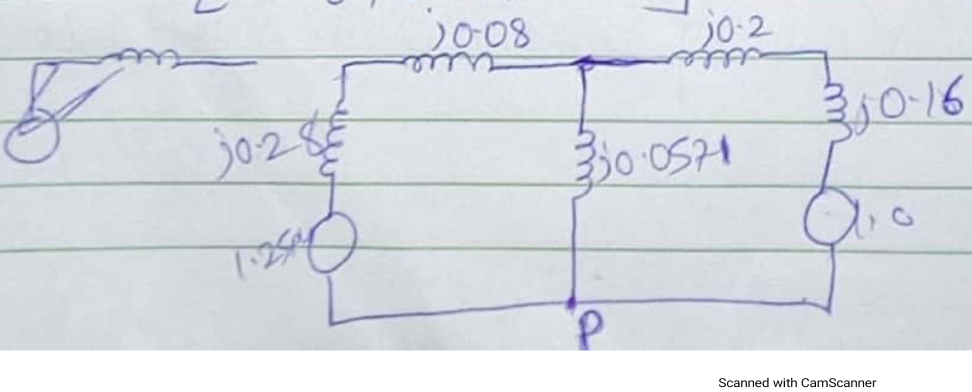


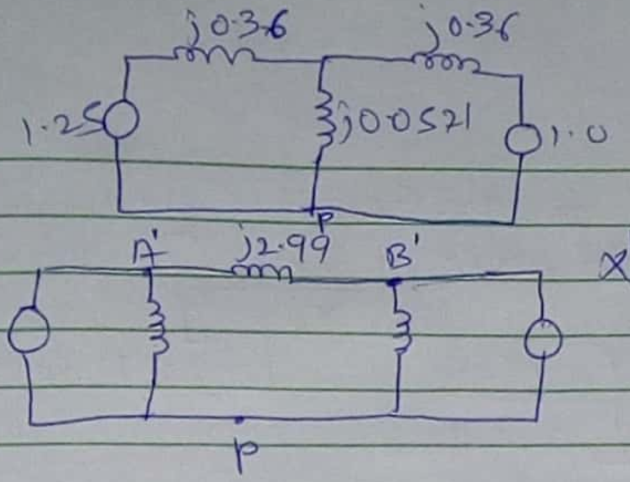
Converting Δ to Y

$$X_{OA} = j\left[\frac{0.56 \times 0.16}{0.56 + 0.16 + 0.4}\right] = j0.08$$

$$X_{OB} = j\left[\frac{0.56 \times 0.4}{0.56 + 0.16 + 0.4}\right] = j0.2$$

$$X_{OP} = j\left[\frac{0.16 \times 0.4}{0.56 + 0.16 + 0.4}\right] = j0.0571$$





Converting Y − Δ

$$x'_{AB} = \frac{0.36 \times 0.0571 + 0.36 \times 0.36 + 0.36 \times 0.0571}{0.0571} = j2.99$$

$$x_2 = j2.99$$

$$P_{max_2} = \frac{1.25 \times 1}{2.99} = 0.418$$

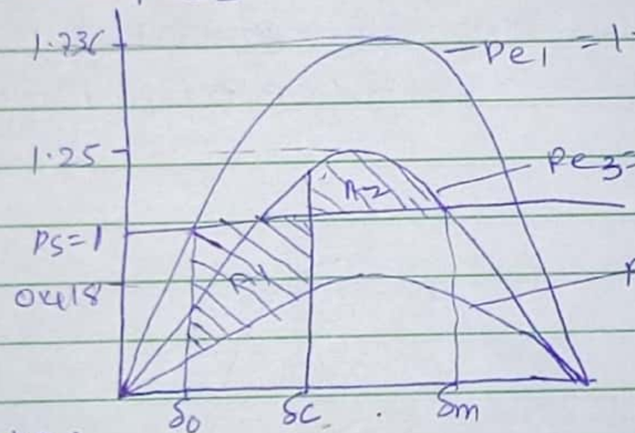
$$P_{e_2} = 0.418 \sin\delta$$

During post fault.

$$x_3 = j0.28 + j0.16 + j0.24 + j0.16 + j0.16 = 1$$

$$P_{max_3} = \frac{1.25 \times 1}{1} = 1.25\,pu$$

$$p_{e_3} = 1.25 \sin\delta$$



(ii) using

$$\cos\delta_c = \frac{(\delta_m - \delta_0)\sin\delta_0 - r_1\cos\delta_0 + r_2\cos\delta_m}{r_2 - r_1}$$

$$r_1 = \frac{P_{max_2}}{P_{max_1}} = \frac{0.418}{1.736} = 0.241\,pu$$

$$r_2 = \frac{P_{max_3}}{P_{max_1}} = \frac{1.25}{1.736} = 0.720\,pu$$

Initial load angle $\delta_0 = \sin^{-1}\frac{P_s}{P_{max_1}} = \sin^{-1}\frac{1}{1.736}$

$= 35.17°$ or 0.614 rad (electrical)

load angle: $\delta_m = 180 - \sin^{-1}\left[\frac{\sin\delta_0}{r_2}\right] = 180 - \sin^{-1}\left[\frac{\sin(35.17)}{0.720}\right]$

$= 180 - \sin^{-1}\left[\frac{0.5760}{0.720}\right] = 126.87°$ or 2.214 rad (electrical)

$$\cos\delta_c = \frac{(2.214 - 0.614)\times\sin(0.614) - 0.214\times\cos(0.614) + 0.720\times\cos(2.214)}{0.720 - 0.241}$$

$$\cos\delta_c = \frac{0.9216 - 0.197 - 0.432}{0.720 - 0.241}$$

$$\cos\delta_c = 0.6109$$

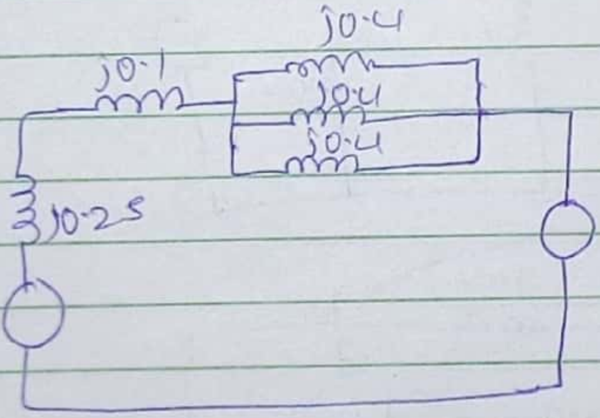
$$\delta_c = \cos^{-1}(0.6109)$$

$$\delta_c = 52.35 \text{ electrical degrees}$$

(2)

f classification of power system stability
- steady state
- Dynamic
- Transient

g



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

$$P_e = \frac{V_t\,|V|\sin\alpha}{X} = 1$$

$$\frac{1\times 1}{0.25 + 0.1}\sin\alpha = 1$$

$\sin\alpha = 0.25 + 0.1$

$\sin\alpha = 0.35$

$\alpha = \sin^{-1} 0.35 = 20.5^\circ$

The current flowing into the infinite bus is given as :

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

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

$= 1 + j0.18$

$= 1.017\angle 10.25$

EMF behind the transient reactance is given as

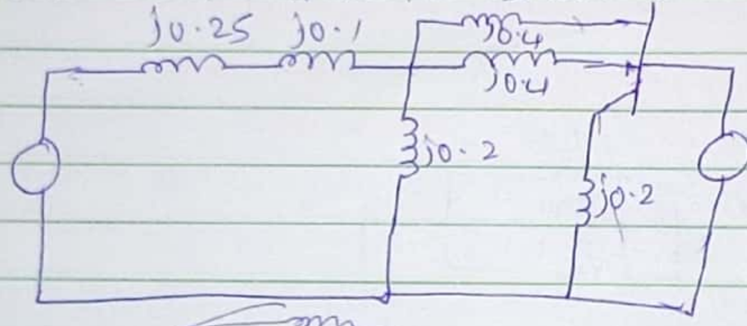
$E' = |V|\angle 0 + IX$

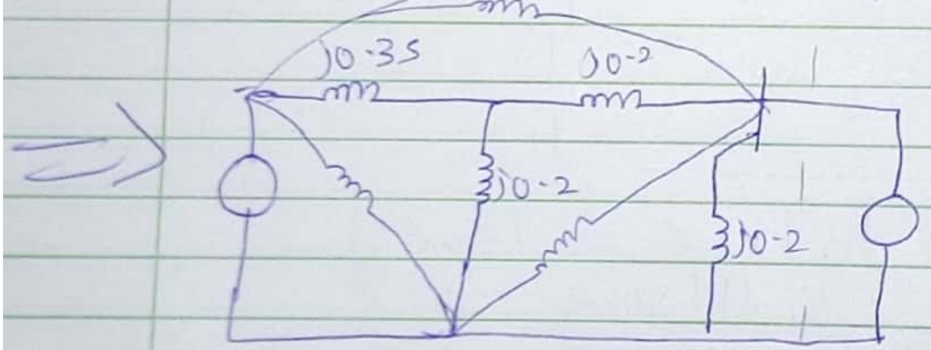
$X_d = j0.25 + j0.1 + \frac{j0.4}{3} = j0.483$

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

$E' = 0.913 + j0.483 = 1.033\angle 27.878^\circ$

(ii) when one line is shorted





Converting 'Y-Δ'

$$x_b = \frac{0.35 \times 0.2 + 0.2 \times 0.2 + 0.35 \times 0.2}{0.2}$$

$$= 0.9$$

$$P_{max} = \frac{|V|\,|E'|}{x_b}$$

$$P_{max} = \frac{1 \times 1.033}{0.9}$$

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