cH 11: Balanced Three-phase Circuit. Three sources Three phase $\equiv 3-\phi$ single - phase $\equiv 1-\phi$ Balanced 3- & Voltages: They are 3 Voltage sources that have identical amplitudes and frequency, but are out of phase with each other by exactly 120° Sequences of balanced . 3-0 Systems 1) positive sequence "abe sequence " Valte Vn Cos (unter Or), Va = Vn 1 Gr Voltl= Vm Cas (we + 6, - 120 1, Vo = Vm 1 6, -120 Velte Vm Cos (ut by 12"/, V= Va 10x+12" Vo C.w 11.6 N V 12. 120 12 VB P P 2) Nazative sequence "acb sequence" T reated using Scan2PDF Doci STUDI By: Mohammad Awawdeh

Va = Vm LEx Vp = Vm LEx+12. V - Vm 161-12. V₆ C.CW 120 110 Va 0000000000000 120 Balanced 3- & Voltages . Eu=0 Va (a) + Vo(I) ~ Vo(I) t- domin Vat Vat V Phaser-domin = V_ Lo" + V_ L-120" + V_ Lizo = Vm + Vm (cosi 20 + j sin(+20)] + Vm (cosi 120) + isin(20) = Vm + Vm Cost20 + Vm cost20 + j (Vm sighted - Vm sight = Vm + 2Vm Cos120 = 0 Instantaneous power in balanced 3-\$ systems (at Va _(-+)_ P(+1= Pa(+1+Pa(+1+Pa(+1) -(--)-Total isstagt mour C-> - Car Docu STUD Uploaded By: Mon mmad awdeh

 $P_a = V_a(t) \dot{c}(\tau) \quad P_b = V_b(\tau) \dot{c}_b(\tau) \quad P_c = V_c(\tau) \dot{c}_c(\tau)$ Assume :. Val+1 = Vm Cos(ut+Gy) · C = Tm Cos(u++Gc) Volal: Van Coslut + 61 - 21 1 10 = Im Coslut + 62 - 21) Velt = Vm Cus(u++Ov+LT) le= Jm Cus(u+Oc+2T) PCH = Valt/ Calt + Volt/ Colt + Klt/ Calt $P(T) = \frac{3}{2} \quad V_m \quad T_m \quad \cos(b_V - G_c) = A \text{ verage Power}$ $\frac{1}{2} = \frac{3}{2} \quad V_m \quad T_m \quad \cos(b_V - G_c) = A \text{ verage Power}$ (No double frequency composed) I'N STANTANEOUS Power p(+1 = 1 Vm Im Cas (0,-Gol + f(2w c) 1-0 Source and Load Connections Source on A Wi mand al 6 + 2

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Va Va Vie V, Load Source and phase Voltages in Y- connected load line VAN Zy VAR in the case $T_L = T_0$ VRN Zy Ved -Ven VBC Tag VAN , VBN , VEN phase Voltages on L-N Voltage VAR, VBC, VCA line Voltage in L-L Voltages Doci STUDI Uploaded By Mohamma Awawdeh

I a A , Ibp , Icc line Currents. Assume o, VAN = Va LEVA VBN = Volever 2 T VCN = VQ LOVO + 27 A A A A A A VAB = VAN - VBN = Valeva - Valeva - 23 Var = (Va Cos (Gval) + j Vasin (Gval) - (Va Cos (Byo - 21) + j Va sin (By - 21) 3 VAO = V3 VO 1640+30 $V_{AB} = (\sqrt{3} \sqrt{3} \sqrt{3} \sqrt{4})$ V, = (V3 130°) the VL-N Fan= (Jstel (Ta Leas) T = (Jstel)

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A _ Connected Load on scarce a. TAR ZA Tax 2. ICA ZA I AR, IRC, ICA => Phase Current TaA, IGB, Icc => line Current VAB, VRC , VCA Phase 16 trages $\overline{I}_{AB} = \overline{I}_{\phi} [\underline{\Theta}_{co} \ , \ \overline{I}_{Bc} = \overline{I}_{\phi} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{cA} = \overline{I}_{\phi} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{cA} = \overline{I}_{\phi} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{cA} = \overline{I}_{\phi} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{cA} = \overline{I}_{\phi} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{cA} = \overline{I}_{\phi} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{cA} = \overline{I}_{\phi} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{cA} = \overline{I}_{\phi} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{cA} = \overline{I}_{\phi} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{cA} = \overline{I}_{\phi} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{cA} = \overline{I}_{\phi} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{cA} = \overline{I}_{\phi} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{cA} = \overline{I}_{\phi} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{cA} = \overline{I}_{\phi} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{cA} = \overline{I}_{\phi} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{cA} = \overline{I}_{\phi} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{cA} = \overline{I}_{\phi} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{cA} = \overline{I}_{\phi} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{cA} = \overline{I}_{\phi} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{cA} = \overline{I}_{\phi} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{cA} = \overline{I}_{\phi} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{cA} = \overline{I}_{\phi} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{cA} = \overline{I}_{\phi} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{cA} = \overline{I}_{\phi} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{cA} = \overline{I}_{\phi} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{cA} = \overline{I}_{\phi} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{cA} = \overline{I}_{co} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{cA} = \overline{I}_{co} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{co} = \overline{I}_{co} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{co} = \overline{I}_{co} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{co} = \overline{I}_{co} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{co} = \overline{I}_{co} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{co} = \overline{I}_{co} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{co} = \overline{I}_{co} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{co} = \overline{I}_{co} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{co} = \overline{I}_{co} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{co} = \overline{I}_{co} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{co} = \overline{I}_{co} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{co} = \overline{I}_{co} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{co} = \overline{I}_{co} [\underline{\Theta}_{co} - \frac{2\pi}{2} \ , \ \overline{I}_{co} = \overline{I}_{co} [\underline{\Theta}_{co}$ $I_{AA} = \overline{I}_{AB} - \overline{I}_{CA} = \sqrt{3} T_{Q} \left[\frac{C_{CQ} - 3}{3} \right]^{\circ}$ $T_{aA} = \left(\sqrt{3} \frac{1}{2^{\circ}} \right) \left(T_{q} \frac{1}{2^{\circ}} \right) \left(1 \frac{1}{q} \frac{1}{2^{\circ}} \frac{1}{2^{\circ}} \right) \left(1 \frac{1}{q} \frac{1}{2^{\circ}} \frac{1}{2^$ $\overline{I}_{A} = \left(\sqrt{3} \left[-3^{\circ}_{\circ}\right] \overline{I}_{AB}\right)$

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Y-Connected load or source V, = (J3 20 Vg IL-IO D - Connected lond or source $\overline{V_{L}} = \overline{V_{d}}$ $\overline{T}_{L} = \left(\overline{J_{3}} \frac{1-3\circ}{2} \right) \overline{T}_{\varphi}$ Y-Y Analysii winding impedance Source local Vain . a' zu ig 24 Zine B VN Voin 61 24 16 111 Zim ZY Vin c' Zu C C Ztine ZV Transmission 1 Generato ZN Kelat Node N $\frac{\overline{V_N} - \overline{V_{a'N}} + \overline{V_N} - \overline{V_{b'}} + \overline{V_N} - \overline{V_{c'n}} + \overline{V_N} = 0}{2\phi}$ ent created using Scan2PDF opleaded By: Mohammad Awawdeh

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 $\frac{3}{Z_{q}} \frac{V_{N}}{Z_{q}} - \frac{1}{Z_{q}} \left(\frac{V_{a'n} + V_{N}}{V_{n} + U_{n}} + \frac{V_{N}}{Z_{N}} - 0 \right)$ $\left(\frac{3}{z_{\phi}} + \frac{1}{z_{N}}\right) \overline{V_{N}} = 6$ $V_N = 0 \rightarrow T_N = 0$ 1-0 equivalent Cincui C a trut 9 Rivine Tap Vain Dame pribries $T_{aA} = V_{an} = T_m L_{Ge}$ Zu+Zinc.+Zy $\overline{J}_{4R} = I_m \begin{bmatrix} G_{0} \\ T_{120} \end{bmatrix}$ $\overline{T} = T_m \left[\Theta_{C} \neq 120^{\circ} \right]$ A balanced 3-Q Y-Connected generator with positive sequence has an impedance of 0.2+jois2/Q and an internal voltage 120V/Q. The generation feels a balanced 3-Q Y-Connected Load having EX an impedance of 39+ 128-2/0, The impedance of [TL] is 0.8+ 11.5 2/0 STUD ded By: Mohammad Awaawdeh

a) Praw the 1-d equivlent Circurt b) Calculare the line Current c) calculare the phase voltage at the load sel. d' = ime voltages " " " " a = ime voltages " " " " TALANTAN AND ALT 39+ 126 12-10- (7 1. Von = Up at a for 10 - 100 - 100 $\frac{1}{1} = \frac{120 100}{(0.2 + 50.5] + (0.6 + 51.5]} = 2.4 \pm 36.874$ $T_{1B} = 2.4 \left[-36.87 - 12^{\circ} - 2.4 \right] \frac{156.67^{\circ}}{156.67^{\circ}} \beta$ $\overline{T_{cc}} = 2.4 \left[-36.87 + 12^{\circ} - 2.4 \right] \frac{133.13}{9}$ c) VAN = (JA) (39+1281 = 115,72 - 119° V $\overline{V_{PN}} = 115.221 - 1.19 - 120^{\circ}$ $\overline{V_{CN}} = 115.221 - 1.19 - 120^{\circ}$ ent created using Scan2PDF

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& VAB = V3 120° (VAN1 VAR = (V30 130) (115,22 [-119° V - 199.5 28.610 VBc = 199.5 121.11-120 V - 199.5 120.91+120° Calculate the phase Voltage at the generator side. Van=(02+1'05)(- Iat + 12010 Vov = 118.9 1-0.320 V60 = 116.92-120 Ven - 118.91-0.32+1200

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V->A A-Connected Load 2 50 Vain A 9 24 ZA Zhan Ziad Vb'n 61 1/2. Zlune 24 -1207 ger erator TL Load A $Z_y = Z_A^2 = Z_A^2$ $3Z_A = 3$ 2, R 2. 1-0 equivalent circent a) ______Zu TaA Vain Ct ZA NI +11-7821-1 4. 2 N n $\frac{\overline{T}}{V} = (\sqrt{3} - 36) \frac{\overline{T}}{7}$ $\frac{\overline{V}}{V} = \sqrt{3}$ Iap - Vain Zu+Zine+2+ 3 nated using Scan2PDF

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POSITIVE SEquence Source: Y- connected feed a D-Connected had - brough a distribution line having an impedance of 0.3 + j'o.9 A/q. The load impedance is 118.5 + j85.8 A/Q, the internal Voltage of phase (01) al The generator is 120 V ms/p a) Construct the 1-& equivelat Curca-CEP # m m 24 6.3A Jo.gr 12010 (+) 118.5 - 185.8 = 39.5 + 128.6 b) calculare the line current IaA = 12020 = 2.41-36.87 0.3+1.9+39.5+122.6 I = 2.4 1-36.87-120 A I_ = 12.4 1-36.874120° A (C) Galculare the phase voltages ar the load sides. AN= (Za) (Ian) = 1124.04 [-0.96" E A der r rest no phase VAR = (+ J 3 13°] VAN = 702.71 129.04 V line o AB VB = 202, 72 29.04 =. 120 VCA = 202.71 [29.04+120

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()) calculate the phase current. $\overline{L}_{1} = \sqrt{3L^{-36}} I_{\beta}$ IAB = IaA 121-30 IAR = 1.39 1-6.87 A I = 1.39 1-6.87-120° A T_A = 1.39 [-6.87+125° A power Calculation in 3-& Circuit P3-4 (+1- Parg 1 P(-1) = Parg + . f(2we) In STANTALCOUS Pointers / $P_{-}=3P_{\phi}$ $\frac{\overline{I}_{ab}}{\overline{I}_{ab}}$ average power power of early Source phace Pd = VA I& Cos(Og) Tic Pore face angle Pa= VAN Cos(EVAN-GIA) PL= VBN ILB Cos (GV - GIB) PC= VEN Ter Cos (GVEN - GIER)

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VAN = VAN = Van = Va 00000000000000000 $\frac{T}{c_A} = T_{bB} = T_{cC} = J_{\phi}$ GVAN - GIA = GVBN - GIB= GVON - GICE = G Pa=Po=Pc=Pø P- = 3 Va Ia Cos(Oo) V1 = J3 VB $T_{L-} I_{\phi}$ $P_T = 3(V_L)(T_L) \cos(\Theta_p)$ $\left(\begin{array}{c}P_{T}=\sqrt{3} \quad V_{L} \quad T_{L} \quad Cos\left(\Theta_{\beta}\right)\right)$ G-z JJ VL IL SM (Gp) Ex P= 3 VJPF Praly- $P = \sqrt{3}$ VIPF , peal $(\frac{1}{2})$ -Doci STUDI By: Mohammad Awawdeh Jploa

B $\vec{S} = P_T + j \vec{Q} T \rightarrow \Theta_{V \varphi} - \Theta_{i \varphi}$ S=J3 VL IL LOP Source $P_T = 3V_{\phi} T_{\phi} C^{(s)} C_{\phi}$ VL = VQ = IL= JJ Ig $P_T = 3V_L \frac{T_L}{\sqrt{2}} \cos(6q) = \sqrt{2} V_L \frac{T_L}{\sqrt{2}} \cos(6q)$ Y-Y Circuit, positive sequence generator, 20 EK Zu=0.2 + jo.5 1/6. Van= 120 V/0 ZLord = 39-+ j2b 1/\$ 1710= 6.8 + 11.5 1/\$ a) calculate the total power delivered to the Lord. a 0.2 + 305 q 0.6+ 31.5 A · []39+ Jibi .!! 12010 (I aA N iont created using Scan2PDF HUB.com

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co e - c 2.4 IaA = 120 Loi - +24 1-6.87° A ·40 +130 x = 1.39 2.4 VAN = (39+j28/(1,39 [36,87°) VAN = 11512 1.19 V (030 + js.2 VL = (V 3 130°) VAN = 202,72 129,04° V $P_7 = \sqrt{3} (1.24) (202.72) \cos(-1.14^\circ - 6.87)$ PT= (72.9% W b) Calculte the total reactive and complex porce believed to the Load $Q_{-} = \sqrt{3} (1.19) (202.72) \sin(-1.19^{\circ} + 6.87^{\circ})$ 4 4 4 4 4 4 4 4 4 $S_{T} = P_{T} + 1'Q_{T} - 2 162.$ c) calculate the total any power lost ~~~~ P1 = 3 JaA (0.2) = (3)(2.4)²(0.8) = 13.824 w Probles 11.9, N. 10 1.16, N.17, N. 19, N. 23, N.25, N.27 res.h. И. 40. Doci STUDI Uploade

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Transformer AC 12-01 220 V induced Voltag-P induced $\alpha \frac{d\phi}{d\tau} = \frac{magnetic}{magnetic} \frac{\beta lux}{d\tau}$ Vs x dd , Ni dt Transformer "Real Transforme Lincar R. s Ra M: maruel coupling [Low] M = K JL, L: "cho" juh E Ejuh T. Coupling 6 + factor Transforme Kulin loop 7 MKulin loop 2: $\overline{T}_{s} = \left(R_{s} + \delta \omega L_{s} \right) \overline{L}_{s} - \delta \omega M \overline{T}_{2} \qquad (2 + R_{s} + \delta \omega L_{s}) \overline{T}_{s}$ $\overline{V_s} = \overline{Z_1} \overline{I_s} - j w M \overline{I_1}, \quad 0 = \overline{Z_2} \overline{I_s} - j w M \overline{I_1}, \quad -j w M \overline{I_1},$ Document created using Scans STUDENTS-HUB.com ploaded By: Mohammad Awawdeh

Reflected impedance Ĵ, 2:0 2 = Ri + jul, + Zref = V. Zin = Ri+ jul, + 2ref $\vec{J}_{i} = \frac{V_{s}}{Z_{i0}}$ $Z_{eq} = \left(\frac{\omega_{M}}{|Z_{21}|}\right)^{2} \cdot Z_{21}^{*}$ 1 Z22 = | R2+ Jul + ZL | I deal Transformer: $R_1 = R_2 = 0$ L L, and L2 - + 00 1- K=1 NI : N2 $\vec{\nabla}_{i} = \begin{bmatrix} \vec{I}_{i} \\ \vec{I}_{i} \\ \vec{V}_{i} \end{bmatrix} \begin{bmatrix} \vec{I}_{i} \\ \vec{V}_{i} \\ \vec{I}_{i} \\ \vec{V}_{i} \end{bmatrix}$ $\frac{V_2}{V_1} = \frac{N_2}{N_1} + \frac{I_1}{I_1} = \frac{N_1}{N_2} + \frac{N_2}{N_1} = a$ Transforme Transition ent created using Scan2 Doci STUDI

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N. Nr Ex - V, + V 1 V 1 $= \frac{\mathcal{N}_{i}}{\mathcal{N}_{I}} \quad \frac{\mathcal{I}_{i}}{\mathcal{I}_{i}} = -\frac{\mathcal{N}_{i}}{\mathcal{N}_{i}}$ a= U2 N $2ref = \frac{1}{a}ZL$ Ex ent created using Scan2PDF Docu STUD Uploaded By: Mohammad Awawdeh