100 -100 Chapter 4: 1 Techniques of circuit Analysis -voltage Method Noce, node 14 V1 21 Step 1: Determine the number of Va 120 essential nodes, ne (A) 2A VOI 54 104 ne=3 1 9 Step 2: Select one of these nodes as a reference nocle 1 لفظ ٥ فتار النوديات علاها فكتر تقدات grano -TO Step 3: Define the node voltages on the circuit essintial self state noces 191 Step 4: Apply KCL at each node 100 21 11 at node Vis -713 alling alle -51 --In 1,22 $1_1 = V_1 - 10$ V, -N 4 101 97 1 iz. T 1322 22 50 V. V2 12=V1 - 0 12 22 = V1-V2 12 10 ° CV 5 al. dejail O.P T. * 3 I IA -

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Ę e 1 0 10 21 KCL at node V2 ° V2 2 12' 1 10 13' D2A 6 1' + 12' + 13' = 06 €; 6 1,1 $i_2 = V_2 - 0$ 13' - Valie 000 $V_2 - V_1$ = €, 2 10 13 =-6 €. 2-0 V2-U 0 6 6 - V2 6 2 C 6 5 (V2-V1) + V2 = 20 XO C 6V2-5V1-20 e 0 10 VI-100 + 2 VI + 5VI-9V2=0 2 C 15V1+2V1-5V2=100 2 17V1 - 5V2 - 100 C 5 6 6 É $v_1 = 9,09$ 6 Julia الاعلى للآفل 21. 1. 22 generator de juice balans $V_{1} = 9.09 V$ Res V2 = 10.91 V1 1 Scanned with Uploaded By: acconstances

Ex & Find Ia, Ib, Ic using Node - voltage method ? 204 50 5u BU GO 5 USING 3A 50V 3 KCL at V ? <u>V-0</u> 40 + (-3) = 0 x 40 <u>V-50</u> 5 V-0 10 8V-400+4V+V = 120 m 1 13V = 520V=40V þ 602 allolis 18 Seguir $I_{A} = 50 - \sqrt{16} = 150 + 40 = 2A$ P 7 $\overline{Ib} = \underline{V-0} = \underline{HA}$ $\frac{T_{c} = V - 0}{40} = 1A$ Ð 7 7 Schulaz 7 3 9 4 D*R - 1x* (5) - (12)* 5. n T. 3 2

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Exã 22 V1 50 12 21 find the power absorbed 200 10 by the 51 resistor 20V (+ 100 8iø e ies using Node Voltage جهد بشم method 2 ال 20 ولکن قيمه عثما محدده 2 KCl at Vi VI 5 € 6 20 6 $I_1 + I_2 + I_3 = 0$ $\frac{v_1-20}{2} + \frac{v_1-0}{20} + \frac{v_1-v_2}{5} = 0 - 0$ 6 6 C KCL at V2 E $\frac{V_2 - V_1}{5} + \frac{V_2 - 0}{10} + \frac{V_2 - 8ig}{2} = 0 - 2$ $\overline{2}$ C عثانه طلع عذى يحصول e e jø 10 = VI-V2 dep source (1) 23 e لا لإلا محادلة res after solving 1 f2 $v_1 = 16V$ $V_2 = 10V$ $i\sigma = 1.2A$ $P = I^2 R = ig^2(5) = (1.2)^2 5 = 7.2$ Walt Scanned with

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21 212 2 0 Exô 0 200 AP 5u vi V2 I 2 50V (A 4A 1004 3 1 Ī 1 $J_{1+}J_{2} + J_{3} = 0$ =0 V1-0 50 وجدال G V1-50 5 ut des R. 2 at Mode 2: -1 12-0 2 عو لادادلين +(-4)=0100 TIL Svi. TH (3) = 1+2T V2 100 + VI-16 TO 1 Veneral ais vera $V_2 - V_1 = 20V$ A 100 100 after solving V2 = 80 V V1 = 60 V Using mesh-current me -9 when a vollage source is between two essential nodes -9 these nodes to form super-node we can combine -20V 51 N > super node -Ð 50V (= (A) HA 100 بروعالم مواللة بالمحط المرد -KOL at super- node: $V_2 - V_1 = 20$ 4 <u>VI-50</u> 5 <u>VI-0</u> 50 V2-0 100 9 1

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Q Mesh current method 21 II IZON 4n Mesh ->-فتاجهالوبه HOV (TILLEBU TO SOUTE 20V فاعنهم التيار مع عقادي الساعة mesh2 mesh3 meght KUL in mesh 1: $-40 + 2T_1 + 8(T_1 - T_2) = 0$ التياريف هجى - التياريف عكسم KUL in mesh 2: $8(I_2 - I_1) + 6I_2 + 6(I_2 - I_3) = 0$ 6 KUL in mesh 32 $6(I_3 - I_2) + 4I_3 + 20 = 0$ ~ 3 by solving 1,2,3 $I_1 = 5.6A$ $I_2 = 2A$ $I_2 = -0.8A$ + VI Vois Sa find vo using mesh-current method $v_0 = 8(I_1 - I_2)$ = 28.8 V Vas Scanned with

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Va Va Va Va Va Va Ex: Find Vo using Mesh-current method? 1.16 ы -Vo -4n 204 15 ig G. ACC. 56V id 10 ACC. mesh 1: Ca $-50 + 5(I_1 - I_2) + 20(I_1 - I_3) = 0$ 100 100 mesh 2: 11 $5(I_2 - I_1) + I_2 + 4(I_2 - I_3) = 0$ The (TO) mesh 3 ? 100 $20(I_2 - I_1) + 4(I_3 - I_2) + 15ig = 0$ 200 iø 1000 $i\sigma = I_1 - I_3$ T, I3 Car - $V_0 = 4 (I_3 - I_2)$ $25T_1 - 5T_2 - 20T_3 = 50$ ~0 -51, + 10 T2 - 4 I3=0 -T Ø = 8V $-5T_1 - 4T_2 + 9T_3 = 0$ 3 103+40 20+2 -70 I1+ 74 I3=0 $45T_{1} - 44T_{2} = 100 - (4)$ $70I_1 = 74I_2$ I_{2-28} $I_1 = 29.6$ I1 = 1.057 I2 $I_{2} = 260$ Vie sie al

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12 44 51 VI 15ig FOV SOV 15iø 200 iø Node voltage method $\frac{v_1 - 15i\phi}{4} = 0$ V1-50 + V1-0 5 20 iø = VI-0 20 V1 20 403 6 6 G 2 SH + 610

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3 Exs Iou 34 5 21 50V 1 ICOV 02 61 41 Jul 1 6I F +3(I. too 0 al e vorlegeipion 13 , hi go voitege gz the b 8(T1-T2) - 100 +V +6 I1 = 0 16 -3(I, -I2) -100. - V + 50 + 4 I2 = 0 T_2 21 + T2 - T2 21 - I2) 50+4 I2 3 - $I_2)$ 10 T2 +3/12-T.) 0 2 2 $l_{1} = 5$ 3 I2. by solvino -I3 = 1.25A = 6.75 A .75 To F -9 -3 . Ð 100 9

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E. The concept of super mesh: **F** ION e 31 II e super mest 22 E (75A (E) (7) 50V 0 100V (1) e ال شكاية المعيارة عن عص محمد في المعرف في المعرف المحالة المح في المعرفة المحمد عليه إذا كان الح في الم e 2 KVL on super mesh ? 2 $-100 + 3(I_1 - I_3) + 2(I_2 - I_3) + 50 + 4I_2 + 6I_1 = 0$ R مرسارة عناع كالعادلين الى قل $T_2 - T_1 = 5 - 0$ super mesh le - 500 €, 6 6 KUL on mesh 3. $10T_3 + 2(T_3 - T_2) + 3(T_3 - T_1) = 0$ -(3) Source Transformation: It allows a voltage source in series with a resistant to be replaced by a current source in parallel with the same resistor 5 F X را السم والارة الحس 5 <=7 Id Vs (1 5 1 y 5 5 $I_s = V_s$ R $\frac{V_{s}}{R} = T_{R} + V_{xy}$ $\frac{R}{T_{s}} = T_{R} + V_{xy}$ 1 1 Scanned with Uploaded By: accompany the second sec

4 Ex : 3 61 51 42 Find the current I in the T corcuit using source transformation HOV 6V (2 200 300 **(†)** method 100 اللف رهاد الجي ocald/ csucisy 6 10 41 0 40 8A W C 1 20 20 10 Jeleon 1 11 1900sil 1 VoHagedla 20/15 A8A 5 =4 32 8x4 く三? 11 6+4+10=20 6 ч Ч 4 P 61 6VE 221 32 Ð 10 9 ч 0-1 9 4 WE 61 1.6A Æ A 1.6A 12 20 × 578 T T 0.825A ч 12 - 6 T = 19.2= 16 67 € @19.2V 12×1.6

4 v? O Thevenin Method Therenin Equivalent circuit : It is an independent voltage source (von) in series with a resistor (Rm) which replace an interconnection of sources & resistors voteo enclos Vollage والأقدمقيراع are inder 3 als lo O=VT source Shor + Rah cime 6 111 دانرقعقوص and Ril as in the RTH UL C. X 6 Thevenin VTL (1 6 Equivalent circuit E Methods to find The Thevenin equivalent circuit. E uethod 1 C Step1: ealculate the open-circuit vollage across the terminals Rrh Voc: open-circuit R 6 voltage I=0 Voc - VTh $I = 0 = V\alpha - Vb$ 13 short arcuit current between Step 2 5 calculate the 10 Rr. X terminals x fy х Isc VTL (F Ise & short circuit current RTH 138 Scanned with Uploaded By: accompany and the second second

1 Dei: 2 M Step 3° Calculate RTL 29 or the 2 (VTh = Voc) -> step1 RTH Isc 2 step 2 3 - she Exa 51 Find the Therenin equivalent 411 circuit across ab 125V (A 20 cub cas Network 11 90 and 51 41 BTL OI + 25V E VTh(+ 20 ob 51 Voc KCL at Voca Spin nodal Noc-25 (-3)=0 25€ Voc-O 2A 201 20 5 as celevi, Vor - VTh = 32 V yn a ٧ 5 ander Eller 20 25 (1)3(20 5 -V = 16V81 $\frac{\mathsf{Tsc} = V = 16}{4}$ YA 322 RTh = VTh Isc 32 = 81 b

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ę ę Helhod 2: It is useful if the network contains only indep sources f resistors 6 6 RTh 6 VT (+ 6 C E Step1: dest E Step 2: Kill all indep sources in the circuit RTH RTh olaster bo ŧ a Short circuit a open circuit Ι seen at terminals calculate the resistance Step30 X Reg = RTh Uploaded By: 200 Scanned with

> 2 N متحذع المستهدز مستظرون الدائرة كاهرج هطوني ففالنت يعرة والتفاقية وعاتمون أسطل N 51 Exa Ling vil drage 25 Voc (1)3A Find the Thevenin Equivelent circuit across Б 2 the terminals aff N Servi Excit 1 de Voc ZO + 0=0 + (-8) Vbs-25 2 le less - dep 800-0151. source 2 VTN = Voc = 82V Stine turns 1 2. Kill Indep Melled 161 - dep - source 10 40 51 or 3 0 R 0 201 the state 6 (m) كاليقطعية للاد 1 -Method 3 8 It is useful if the circuit contains dep - sources -0 to do in Step 1: calculate the open circuit voltage --19 Voc = VTL 1 (11 N831 Step 2° Kill all indep sources in the circuit (1 RTh ف) هصدر سارح واعطية اده قيمة 1 Gulf (VTest ciestes des 1= 19 1 1 9 D

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K 6 6 6 Step 30 Apply alest source on the terminals xy RTH E e Stepy: calculate Rin RTH = VT Ex: Find the Themenin equivalent circuit with respect to terminal ab. للكا فتهجه والطريق سفالقولتج MS Con dep Gow 7 UN yV VOC - VTL J. D) 4A Kel at VTL -= 0 VTh 8 ix = VT VTh 8 2 8V ixl \$8n 8 + $\frac{1}{8} = \frac{VT - 0}{8}$ VT = IT RTH Scanned with Uploaded By: อาการอาการ

222222222 Exs Calculat V using Thevenin Method , P.Th VILE (F)60V 200 1 36A VS 81 51 120-5 4 y Vallage Thevenin div 2 Equibulent Circuit 6 V= 8 2 8+R-2 1.61 1 20 1 126 note : when X are curren 120 5 -Flows through the 6 11 because there's no clocal pull VTh the current to circulate As a resu v 36 there's no current flowing throug 20 Rz R. 1206 100 é ... 1 Ra R. الدرج 2 あい 120 20 5L GUG VT -600 Solve for VTL 51 5 515 or 2 no need to use method 3 there is no indep , Method to find RTHING 1.6 -51 (20/15) = 461 RTh 4 201 (4116) = 2.4_____ 402 $(2.4'+1.6) = 4\Lambda$ Y 14 + Jul 384 VTh = 48V -4 8+4 10 E C C Scanned with

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Norton Equivalent circuit It is the source transformation of thevenin equivalent circuit RTHX IN IN = VTh VILE RT RT L У short circuit curren Methock to find the Norton equivalent circuit between B Step1 : calculate the open circuit voltage, Vac VTh = Voc Step 2° calculate the short circuit current IN-IG Tec 30 00 Step 3° calculate the RTh = VT 523 TN 03 X 4 2] A.E using the methods of the verin equivalent circuit with source transformation i Scanned with

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Ex. Find the Norton equivalent circuit with respect to the terminals ab 2 V 9 (astras) 3 15AG \$121 84 lou 2 2 1 current divider 75 A 15 2 (3) T -8 8+ (2+12+10) 24 = 12 T VTh or by Node 41 =15 = 0 -15 8 24 24 المعدالكل 90 Voc = E (x) (12 2 90 UF JA+X (12) + 2+10 AR BA 38 IN = Isc القرابرعذ ا 1SA (1 IN = I نفرعد 8 القولي عا القادية 6 10 10 I=Y=0 ARTA 5 Frostão go short 20 current IN = 8 .15 = a gall (sel 196 od hussio 66 6A 8+12 (Ť RTH 1512612612 0 1.5. 7.51 IN SMALL Y 1.014 116 11.0112026 Alt 212 2h 1

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Maximum power Transfer what is the value of RL such that the power absorbed by RL Resist Adı RI retubil LAGA is maximum? resistance NO IL Eloud current RL RTA+RL The power absorbed by RL: VTL RTL+RI .RI Ru R يست F(x) . -0 RL = RTL dRL 00 vins Cuo 916 Li Mar N Ger الحر هم 16 4 20 Valer 2 01 P. max VTh HRTH Ex: Find the value of RL to enable the circuit to deliver maximum power and find the maximum powe delivered to RL 44 assismant problems 41 42 VÓ R Ь Scanned with

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4N VØ RL = RTL 412 100 2 44 T VTh Poncer 1000 4Rm VTI 20V 1-20 Tealles U 20 dir V& +100) VI -20 -100 Ч 8 4 is ショ Vor+20-20 Vor + 20-100 V& +70 - V& +100 8 Vø 20 12 30 2 motore 23 10 = 60 V& +26 (2)H = VTh 4T = 10A VØ +100) - (VØ +20) iest 8 4(5 VTL 40+60+20 = 120 V 5P+2 41 語く 41 RTh "Nethod 3" 4.4 IN.O 41) ish JIMIK NT Vr. وج حسالي إذا 11 Vieipell 42 Vø 1 VT T-VQ =0 -0 4 - Vor+ 4J F 4/14 Fil 2 VT Vx VT_ 2+4 V-T Ξ 3

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42 VØ RL = RTh 412 44 2 T VTh Power 1000 4RTL Yn 201 V1-20 - della +20 Vor +100 100 8 Va+20-Va+100 20-100 Vor+20-20 20 Va 2 10 = 60 Va +26 VTh = 4T $-(v_{0}+20)$ (VØ +100) = 10A iss 8 40+60+20 = 120 V VTL -41 VT 41 RTh "Nethod 3" Julita VT dai J'esta وج حدال إذا المج تغرام 42 VT-VØ Y y -0 VT. =(٩ - Vort 4P t 4//4 2 JVT 3 (Ŧ) Ve VT Vø 2 VT 2+4

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 $-I_T + V_T + I_V_T = 0$ $\frac{J_T = V_T}{2} \qquad \begin{array}{c} R_T L = V_T = 3L \\ T_T \end{array}$ RL = 31 $p_{max} = V_{Th}^2 = 120^2 = 1.2 \text{ KW}$ 6 Superposition ? For any linear system is driven by more than one indep Source, the total response is the sum of the individual resconses 3, linear differential equation 4 linear system $a_2 d^2 y + a_1 dy + a_0 y = u(t)$ $\frac{y(s)}{u(s)} = H(s)$ $(u_2 S^2 + q_1 S + q_0) y(s) = u(s)$ $\frac{y}{\alpha_{z}} = \left(\frac{1}{\alpha_{z}} \frac{1}{s^{2} + \alpha_{z}} \right) \frac{u(s)}{u(s)}$ - ulging a2 y" + a, y1 + 0, 0 = u voHuge rewi vier $q_2 y_1'' + q_1 y_1 + q_0 = u_1$ Q2 42 + Q1 2+ Q0 = 42 y+ 42 output d' 26 130 linear of rule jet pu Uploaded By: aconstant