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Multiple subsystems can share controllers with time. Any adjustments to the controller can be implemented only with software changes. 8. Stability, temporary response, and stable status error 9. State-stabilized, while 10. This follows a growing temporary response until a stable state response is no longer visible. The system will self-destroy, achieve a state of balance due to saturation in the driving of the amplifier, or hit the stop limit. 11. Natural response 12. Specify the performance of the system's interim response. 13. Specify system parameters to meet temporary response specifications for the system. 14. True 15. Transfer function, country space, differential equation 16. Transfer function - Laplace transformation of State-space differential equation - representation of nth sequence differential equation as first sequence differential equation n concurrent differential equation - System modeling with differential equation SOLUTION TO PROBLEM 1. Five rounds yields 50 v. Therefore K = 50 volts 5 x 2rrrad = 1.59 Academia.edu use cookies to personalize content, customize ads, and improve the user experience. By using our site, you consent to the collection of our information through the use of cookies. To learn more, see our Privacy Policy.× Home > Engineering ebook > Free download Control System Engineering by Norman S.Nise Solution Manual 6th edition Hope that you all I'm fine too. Today in this post I will share a solution manual from Control System Engineering by Norman S.Nise. If you have a solution guide on your hands, then you can learn more correctly. Hope that this solution will help you in your course of study. So let's download this book. Size: Download Link 14MB: Free download Control System Engineering by Norman S.Nise Solution Manual 6th edition Title: Free download Control System Engineering by Norman S.Nise Solution Manual 6th edition Posted by : Himadri Date : 21:17:00 Labels : Engineering ebook 1. E1SM 11/11/2010 9:29:8 Page 1 Solution for Skill Assessment Exercises CHAPTER 2 2.1 Laplace t Transformation is 1 s2 using Table 2.1, Item 3. Using Table 2.2, Item 4, F- 1/4 1 s i 5Þ Þ2 . 2.2 Expanding F(s) with partial fractional results: F s N 1/4 A s i B s i 2 i C s i ì 3Ð Þ2 i D s i ì 3Ð Ve where, A 1/4 10 s i 2Ð you include 3Ð Þ2 SÌ0 1/4 5 9 B 1/4 10 s s i 3Ð Þ2 S! Á2 1/4 Á5 C 1/4 10 s s i 2Ð You S! Á3 1/4 10 3; and D 1/4 s i 3Ð Þ2 dF, you ds! Á3 1/4 40 9 Take inversion Laplace change the result, f tÐ You 1/4 5 9 A SeÁ2t i 10 3 teÁ3t i 40 9 eÁ3t 2.3 Take the Laplace transformation of the differential equation assuming zero initial condition result: s3 C, i.e. 3s2 C, i.e. 7sC, including 5C, including 1/4 s2 R, i.e. 4sR, i.e. 4sR, including 3R, You Collect terms, s3 i 3s2 i 7s i 5 Á On C- 1/4 s2 i 4s i 3 Á At R. Thus, C- You R- 1/4 s2 i 4s i 3 s3 i 3s2 i 7s i 5 1 2. E1SM 11/11/2010 9:29:8 Page 2 2.4 G- 1/4 C, You R. 1/4 2s i 1 s2 i 6s i 2 Cross multiply results, d2 c dt2 i 6 dc dt i 2c 1/4 2 dr dt i r 2.C. You 1/4 R. s 1/4 1 s2 Ã s i Áð You're ie ßð You 1/4 1 s i 4ð You're ie ßð You 1/4 A s i B s i 1 Áð You i C s i ßð You where A 1/4 1 s i 4ð You s i ßð You SÌ0 1/4 1 32 B 1/4 1 s i ßð You S! Áß 1/4 1 32 Thus, c− 1/4 1 32 Á 1 16 and C 1/4 1 s i 4ð You S! Áß 1/4 1 32 eÁ8t 2.6 Mesh Analysis Altering network results, +V(s) I1(s) I2(s) V1(s) V2(s) I9(s) + 1 s s __ Now, write a mesh equation, s i ìð PI1, you Á s!2, you Á I3, you 1/4 V, You Ás!1, ie 2s i ì1 V, You 1/4 s V- Solving for VL 1/4 1 s i 2 V, you Á1 1 s V, You 1 s i 2 Á1 Á1 2 s i 1 1/4 s2 i 2s i 1 Á On V, you s2 i 5s i 2ð you or VL, you V, 1/4 s2 i 2s i 1 s2 i 2 i 5s i 2 Nodal Analysis Writing nodal equation, 1 s i 2 V1, you Á VL, you 1/4 V, your ÁV1, ie 2 s i 1 VL, you 1/4 1 s V- Solving for VL 1/4 1 s i 2 V, you Á1 1 s V, You 1 s i 2 Á1 Á1 2 s i 1 1/4 s2 i 2s i 1 Á On V, you s2 i 5s i 2ð you or VL, you V. 1/4 s2 i 2s i 1 s2 i 2 i 5s i 2 Nodal Analysis Writing nodal equation, 1 s i 2 V1, you Á1 1 s V, You 1 s i 2 Á1 Á1 2 s i 1 1/4 s2 i 2s i 1 Á On V, you s2 i 5s i 2ð you or VL, you V. 1/4 s2 i 2s i 1 s2 i 5s i 2 2.7 Inverting G- 1/4 Á 22, You Z1, you 1/4 Á10000 105 =s 1/4 As Noninverting G- 1/4 Z1, ie Z. 1/2 S Z1, you 1/4 105 s i 105! 105 s! 1/4 s i 1 2.8 Writing mesh equations, s2 i 3s i 1 Á On X1, you Á 3s i 1ð bX2, You 1/4 F, You Á 3s i 1ð bX1, ie s2 i 4s i 1 Á On X2, You 1/4 0 Chapter 2 Solutions for Skill Assessment Exercises 3 4. E1SM 11/11/2010 9:29:9 Page 4 Solving for X2(s), X2 sð You 1/4 s2 i 3s i 1 Á On F- You Á 3s i 1ð You 0 s2 i 3s i 1 Á On Á 3s i 1ð You Á 3s i 3s i 3s i 1ð You s2 i 4s i 1 Á On 1/4 3s i 1ð bF s s3 i 7s2 i 5s i 1ð You Hence, X2, You F. 1/4 3s i 1ð You s s3 i 7s2 i 5s i 1ð You 2.9 Writing the equations of motion, s2 i m i 1 Á On u1, you Á s i 1ð Þu2, You 1/4 T, you Á s i 1ð Þu1, namely 2s i 2ð Þu2 , You 1/4 0 where u1 is the angular displacement of the inertia. Solve for u2, u2 sð You 1/4 s2 i m i 1 Á On T- You Á s i 1ð You 0 s2 i i Á On Á s i 1ð You Á s i 1ð Þu2 You 1/4 s i 1ð 2s2 i 3s2 i 2s i 1 Á From where, after simplification, u2 s That's 1/4 1 2s2 i m i 1 2.10 Turn the tissue into one without gears by reflecting the spring 4 N-m/rad to the left and multiplying with (25/50)2 , we get, Writing motion equations, s2 i s Á On u1, You Á sua, you 1/4 T, you Ásu1, ie 1ð You 1/4 0 where your u1 is the displacement angle of the inertia of 1 kg. Solve for u1, ua, you 1/4 s2 i s Á On T- Ás 0 s2 i s Á On Ás Ás i s 1ð You 1/4 sT sð You s3 i s2 i s 4 Solutions for Skill Assessment Exercises 5. E1SM 11/11/2010 9:29:9 Page 5 From where, ua, You T, 1/4 1 s2 i m i 1 But, u2, you 1/4 1 2 ua, you: Thus, u2, you T. 1/4 1 =2 s2 i i 1 2.11 First find mechanical constants. Jm 1/4 Well i JL 1 5 Ã 1 4 2 1/4 1 i 400 1 400 1/4 2 Dm 1/4 Da i DL 1 5 Ã 1 4 2 1/4 5 i 800 1 400 1/4 7 Now find an electrical constant. From the torque speed equation, set the vm 1/4 0 to find stall torque and set tm 1/4 0 to find speed without load. Therefore, Tstall 1/4 200 vnoÁload 1/4 25 yang, Kt Ra 1/4 Tstall Ea 1/4 200 1/4 2 Kb 1/4 FaJm s i i Jm Dm i KTKb Ra 1/4 s i i 5 2 where about you is armature angle displacement. Now uL, you're 1/4 1 20 on you. So, uL, you Ea, you 1/4 1 = 20 s s i 15 2 2.12 Let u1, you 1/4 v1, you = u2, you 1/4 v2, You = s Chapter 2 Solutions for Skill Assessment Exercises 5 6. E1SM 11/11/2010 9:29:9 Page 6 in Eqs. 2127, we get J1s i D1 i K s v1 sð You Á K s v2 sð You 1/4 T, You Á K s v1 Þ þ J2s þ D2 þ K s v2 sð Þ From this equation we can draw both series and analog parallels by considering these to be mesh or nodal equations, respectively. – + J1 J1 J2 J2 D1 D1 D2 D2 T(t) T(t) w1(t) w1(t) w2(t) w2(t) 1 1 K 1 Series 1 Analog Parallel K 2.13 Write nodal equations, C dv dt þ ir Á 2 1/4 i tð Þ Ðut, C 1/4 1 v 1/4 vo þ dv ir 1/4 evr 1/4 ev 1/4 evoþdv Substituting this relationship into differential equations, d vo þ dvð Þ dt þ evoþdv Á 2 1/4 i tð Þ ðb1Þ We now linearize ev. Common forms are f vð Þ Á f voð Þ % df dv vo dv Substituting function, f vð Þ 1/4 ev , with result v 1/4 vo þ dv, evoþdv Á evo % dev dv vo dv 6 Solution for Skill Assessment Exercise 7. E1SM 11/11/2010 9:29:10 Page 7 Solution for evoþdv , evoþdv 1/4 evo þ dev dv dv dv 1/4 evo þ evo dv Substituting to Eq. (1) ðdv dt þ evo þ evo dv Á 2 1/4 i tð Þ ðb2Þ Setting i tð Þ 1/4 0 and let the circuit achieve a stable state, capacitors act like open circuits. Thus, vo 1/4 vr with ir 1/4 2. But, ir 1/4 evr or vr 1/4 Inir. Therefore, vo 1/4 in 2 1/4 0.693. Substitution of this vo value to Eq. (2) produces ddv dt þ 2dv 1/4 i tð Þ Takes Laplace transformation, s þ 2ð bvð sð Þ 1/4 I sð Þ Solving for transfer function, we get dv sð Þ I sð Þ 1/4 1 sþ 2 or V sð Þ I sð Þ 1/4 1 sþ 2 about balance: CHAPTER 3 3.1 Identify the corresponding variables on the circuit results - + - + C1 iL iC2 i iC iR C2 R L vo(t)v1(t) Write derivative relationships C1 dvC1 dt 1/4 iC1 L diL dt 1/4 vL C2 dvC2 dt 1/4 iC2 ðIÞ Chapter 3 Solutions for Skill Assessment Exercises 7 8. E1SM 11/11/2010 9:29:10 Am Page 8 Using Kirchhoff's current laws and voltage, iC1 1/4 iL þ iR 1/4 iL þ 1 R vL Á vC2 ð Þ vL 1/4 ÁvC1 þ vi iC2 1/4 iR 1/4 1 R vL Á vC2 ð Þ Substituting this relationship to Eqs. (1) and simplify generating state equations as dvC1 dt 1/4 Á 1 RC1 vC1 þ 1 C1 iL Á 1 RC1 vC2 þ 1 RC1 vi diL dt 1/4 Á 1 L vC1 þ 1 L vi dvC2 dt 1/4 Á 1 RC2 vC1 Á 1 RC2 vC2 1 RC2 vi where the output equation is vo 1/4 vC2 Placing the equation in vector-matrix form, _x 1/4 Á 1 RC1 1 C1 Á 1 RC1 Á 1 L 0 0 Á 1 RC2 0 Á 1 RC2 2 6 6 6 6 6 6 6 3 7 7 7 7 7 7 7 5 x þ 1 RC1 1 L 1 RC2 2 6 6 6 6 6 6 6 4 3 7 7 7 7 7 7 7 5 vi ðtÞ þ y 1/4 0 0 0 1 1/2 Šx 3.2 Write equations of movement s2 þ sþ 1 Á Á X1 sð þ Á 1/4 F sð þ ÁsX1 sð þ þ s2 þ sþ 1 Á Á X2 sð þ ÁX3 sð þ 1/4 0 ÁX2 sð þ s2 þ s þ 1 Á Á X3 sð þ 1/4 0 Taking inverse Laplace transforming and simplifying, €x1 1/4 Á_x1 Á x1 þ _x2 þ f €x2 1/4 _x1 Á _x2 Á x2 þ x3 €x3 1/4 Á_x3 Á x3 þ x2 Define country variables, zi, z1 1/4 x1; z2 1/4 _x1; z3 1/4 x2; z4 1/4 _x2; z5 1/4 x3; z6 1/4 _x3 Solutions for Skill Assessment Exercises 9. E1SM 11/11/2010 9:29:10 AM Page 9 Writing status equations using status variable definitions and inversions of definitions, _z1 1/4 z2 _z2 1/4 €x1 1/4 Á_x1 Á x1 þ _x2 þ f 1/4 Áz Á z1 þ z4 þ f _z3 1/4 _x2 1/4 z4 _z4 1/4 €2 1/_x1 <7> Á _x2 Á x2 þ x3 1/4 z2 Á z4 Á z3 þ z5 _z5 1/4 _x3 1/4 z6 _z6 1/4 €x3 1/4 Á_x3 Á x3 þ x2 1/4 Áz6 Á z5 þ z3 The output is z5. Therefore, y 1/4 z5. In vector-matrix form, _z 1/4 0 1 0 0 0 Á1 Á1 0 1 0 0 0 0 0 0 0 1 Á1 Á1 1 1 0 0 0 0 0 1 0 1 0 1 Á1 2 6 6 6 6 6 6 6 6 4 3 7 7 7 7 7 7 7 7 5 z þ 0 1 0 0 0 0 2 6 6 6 6 6 6 6 6 4 3 7 7 7 7 7 7 7 7 5 f tð Þ; y 1/4 0 0 0 0 0 1 01/2 Šz 3.3 First obtain the state equation for the transfer function without zero. X sð Þ R sð Þ 1/4 1 s2 þ 7s þ 9 Cross multiplies the result of s2 þ 7s þ 9 Á X sð Þ 1/4 R sð Þ Take the Laplace transformation inversion assuming zero initial conditions, we get €xð _7_x þ 9x1/4 r Defines a country variable as a country variable as x1 x 1/4 _x _x1 1/4 x2 _x2 1/4 €x 1/4 Á7_x Á 9x þ r 1/4 Á9x1 Á 7x2 þ r Using zero transfer function, we find the equation output to be, c 1/4 2_x þ x 1/4 x1 þ 2x2 Put all equations in the result of vector-matrix form, _x 1/4 0 1 Á9 Á7 # xþ 0 1 # r c 1/4 1 21/2 Šx Chapter 3 Solution for Skill-Training Assessment 91 E1SM 11/11/2010 9:29:11 Page 10 3.4 State equation converted to transfer function using G sð þ 1/4 C sI Á Áð þÁ1 B ð1Þ where A 1/4 Á4 Á1 5 4 0! ; B 1/4 2 0!; and C 1/4 1:5 0:625!2 S: Evaluating sI Á Áð þ produces sI Á Áð þ 1/4 sþ 4 1:5 Á4 s! Taking the opposite we get sI Á Áð þÁ1 1/4 1 s2 þ 4s þ 6 s Á1:5 4 s þ 4! Substitution of all expressions to Eq. (1) produces G sð þ 1/4 3s þ 5 s2 þ 4s þ 6 3.5 Write differential equations we get d2 x dt2 þ 2x2 1/4 þ df tð Þ Á1Þ Letting x 1/4 xo þ dx and substitution to Eq. (1) result d2 xo þ dxð Þ dt2 þ 2 xo þ dxð P2 1/4 þ df tð Þ ðb2Þ Now, linearize x2 . xo þ dxð P2 Á x2 o 1/4 d x2 Á A dx xo dx 1/4 2xodx from which xo þ dxð P2 1/4 x2 o þ 2xodx ðb3Þ Substituting Eq. (3) to Eq. (1) and performing the indicated differentiation gives us a linearized intermediate differential equation, d2 dx dt2 þ 4xodx 1/4 A2x2 o þ þ 10 þ df tð þ ðb4Þ Spring strength on balance is 10 N. Thus, since F 1/4 2x2; 10 1/4 2x2 o from where xo 1/4 ffffff

unstable. Instability can also be determined using the Routh-Hurwitz criteria on the T denominator. 7.2 a.m. The system is stable, since T- 1/4 G- 1 i G-1/4 1000 s i ßð You're i 1000 s i ßð You'r e i 1000 s i ßð You 1/4 1000 s i ßð You 1/4 1000 s i ßð You s2 i 1016s i 8063 and type 0. Therefore, Kp 1/4 lim s!0 G- 1/4 1000Â 8 7Â 9 1/4 127; Kv 1/4 lim s!0 sG, you 1/4 0; estep 1ð anda 1/4 i i lim s!0 G- 1/4 i i 1/4 i i 1/4 i i i 1/4 i 127 1/4 7:8e Â 03 eramp 1ð You 1/1 4 1 lim s!0 sG sÐ 1/4 1 0 1/4 1 eparabola 1ð You 1/4 1 lim s!0 s2 G-1/4 1 0 1/4 1 Chapter 7 Skill Assessment training solutions 19 20. System E1SM 11/11/2010 9:29:16 Page 20 7.3 stable for K. Positive system is Type 0. Therefore, for input hop estep 1ð You 1/4 1 1 i Kp 1/4 0:1. Breakdown for kp kp results 1/4 9 1/4 lim s!0 G-1/4 12K 14Â 18; from where we get K 1/4 189. 7.4 Stable system. Since G1, you 1/4 1000, and G2, you 1/4 s ð ð ð ð you include 4ð You, eð 1ð You 1/4 Â 1 lim s!0 1 G2, ge ð1 s!0, You 1/4 1 2 i 1000 1/4Â 9:98e Â 7.5 Stable system. Since G1, you 1/4 1000, and G2, you 1/4 s ð ð ð ð you include 4ð You, eð 1ð You 1/4 Â 1 lim s!0 1 G2, ge ð1 s!0, You 1/4 1 2 i 1000 1/4Â 9:98e Â 7.5 Stable system. Since G1, you 1/4 1000, and G2, you 1/4 s ð ð ð ð you include 4ð You, eð 1ð You 1/4 Â 1 lim s!0 1 G2, ge. G- You 1/4 100 s i ð ð You Â 100s i 1ð You're including 4ð You 1/4 100 s i 1ð You S2 Â 95s i 4 Hence, the system is Type 0. Evaluating the results kp Kp 1/4 100 4 1/4 25 Stable status errors given by estep 1ð You 1/4 1 1 i Kp 1/4 1 1 i 25 1/4 3:84e Â 02 7.6 Since G- 1/4 K s i 7ð You s2 i 2i 2s i 10; e 1ð your 1/4 1 1 i Kp 1/4 1 1 i 7K 10 1/4 10 10 i 7K . Calculating sensitivity, we get Se:K 1/4 K e @e @K 1/4 K 10 10 i 7K Â1ð0 7ð 10 i 7Kð You2 1/4 Â 7K 10 i 7K 20 Solutions for Skill Assessment Exercises 21. E1SM 11/11/2010 9:29:16 Page 21 7.7 Given 1/4 0 1 Âð Â6 1; B 1/4 0 1! C 1/4 1 11/2 Š; R sð Þ Ý Ý Ý 1 s : Using the final value theorem, estep 1ð Ý 1/4 lim s!0 sR sð Þ 1 Â C s! Â ð PÁ1 B Ý 1/4 lim s!0 1 Â 1 1½ Š s Ý 1 Â 1½ Š s Ý 1 Â 1½ Š s Ý 1 Â