BILGI UNIVERSITY
Faculty of Engineering and Natural Sciences
Department of Electrical and Electronics Department

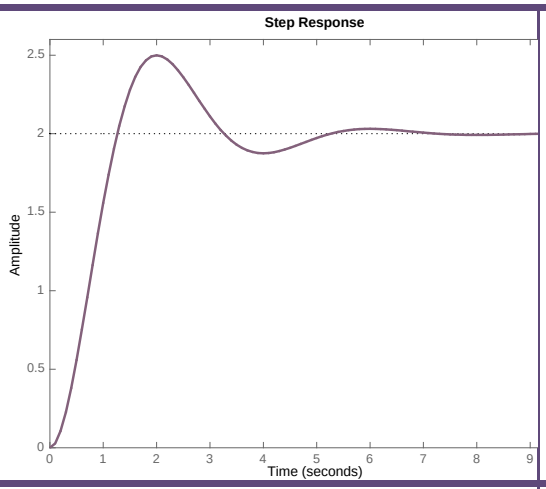
Course: EEEN 352 System Dynamics and Control
Instructors: Prof. Dr. Mehmet Nur Alpaslan Parlakçı & Prof. Dr. Şeref Naci Engin
Exam/Date: Quiz-1/17.04.2020, 09:00 – 10:00, **Duration:** 45 min. **Signature:**
Student Name: **Student Number:**

Problem. For each of the transfer function ***(i, ii, iii),*** a response plot ***(iv)*** and given specs ***(v)***, all representing second order systems, do the following so that you can fill in the table with your results.

- **(a)** Find the natural frequency and damping ratio values, then determine the locations of the poles
- **(b)** Determine the kind of the unit step time responses (overdamped, undamped, etc.) and write their general forms,
- **(c)** Find the steady-state, c_{ss}, and peak values, c_{max}, of the responses. *Necessary formulas are at the bottom.*
- **(d)** Find the settling and peak times, T_s and T_p (if appropriate), respectively.
- **(e)** Propose new transfer functions that produce unit step responses two times (2x) slower in terms of settling time while maintaining the same form (the same ζ) and steady-state values.

(i) $G_1(s) = \frac{18}{(s+2)(s+5)}$, ***(ii)*** $G_2(s) = \frac{12}{s^2+4s+16}$, ***(iii)*** $G_3(s) = \frac{12.5}{s^2+5s+6.25}$,

(iv) $G_4(s)$: *The plot,* ***(v)*** $G_5(s)$: 10% OS, $T_s = 4$ sec, $c_{final} = 3.5$

Transfer Functions / **Questions**	(i) $G_1(s)$	(ii) $G_2(s)$	(iii) $G_3(s)$	(iv) $G_4(s)$ 	(v) $G_5(s)$
1. ω_n	1, *i*	1, *ii*	1, *iii*	1, *iv*	1, *v*
2. ζ, *%OS*	2, *i*	2, *ii*	2, *iii*	2, *iv*	2, *v*
3. Poles	3, *i*	3, *ii*	3, *iii*	3, *iv*	3, *v*
4. Kind	4, *i*	4, *ii*	4, *iii*	4, *iv*	4, *v*
5. General Form	5, *i*	5, *ii*	5, *iii*	5, *iv*	5, *v*
6. T_s	6, *i*	6, *ii*	6, *iii*	6, *iv*	6, *v*
7. T_p	7, *i*	7, *ii*	7, *iii*	7, *iv*	7, *v*
8. c_{ss}	8, *i*	8, *ii*	8, *iii*	8, *iv*	8, *v*
9. c_{max}	9, *i*	9, *ii*	9, *iii*	9, *iv*	9, *v*
10. New (10, *i-iii*) and Proposed (10, *iv-v*) Tr. Fn.	10, *i*	10, *ii*	10, *iii*	10, *iv*	10, *v*

$T_p = \frac{\pi}{\omega_n\sqrt{1-\zeta^2}}$, $T_s \cong \frac{4}{\zeta\omega_n}$, $\%OS = 100.e^{-\zeta\pi/\sqrt{1-\zeta^2}}$, $\zeta = \frac{-\ln(\%OS/100)}{\sqrt{\pi^2+\ln^2(\%OS/100)}}$, $\lim_{t\to\infty} f(t) = \lim_{s\to 0} sF(s)$, *Good luck!*