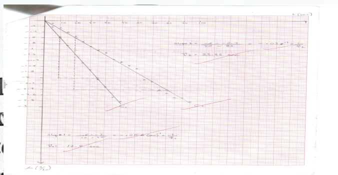
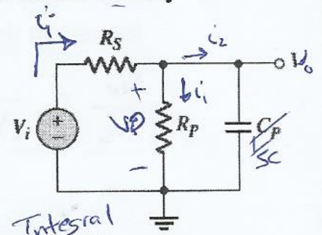


ersity of Jordan
cal Eng. Dept.

Contro Systems EE441	irst Exam	Thurs. 26/10/2014	5
Student Name in Arabic		Registration #: 0110494	
Answers should be writt	ration:50 min	Mark out of 20:	

Question 1 Consider the circuit shown.
Obtain a **detailed block diagram** representation of the circuit with V_o as output and V_i as set value. Clearly indicate on it where to measure Vo , Is , Ip , I_C .



$i_s = i_p(t) + i_c(t)$ --- (1)

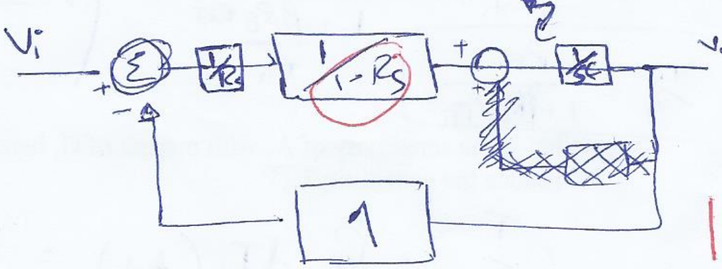
By current division → $i_c(t) = \dfrac{R_p\, i_s(t)}{(R_p + C_p)}$ X

$V_i(t) = i_s R_s + i_p R_p$ ---- & $V_o(t) = \frac{1}{c}\int i(t)\,dt$

Laplace Transformation :

$I_s(s) = I_p(s) + I_c(s)$

$I_c(s) = \dfrac{R_s\, I_s(s)}{(R_p + \frac{1}{sc})}$



Use **block diagram reduction techniques** to determine $Vo(s)/V_i(s)$.

$V_i(s) = I_s(s) R_s + \cancel{I_p(s) R_p}\ V_o(s)$

$V_i(s) = I_s(s) R_s + \frac{1}{sC} I_s(s)$

$\cancel{V_i(s) = I_p(s) * R_p + I_p(s)}$

$V_i(s) = I_p(s) + \dfrac{V_o(s)}{R\frac{1}{sc}} + V_o(s)$

$V_i(s) = I_p(s) + V_o(s)\left(\frac{1}{sc} + 1\right)$

$V_i(s) = \dfrac{V_i(s) - V_o(s)}{R_s} + V_o(s)\left(\frac{1}{sc} + 1\right)$

not like this

* By voltage division :

$V_P(s) = \dfrac{V_i(s)\, R_s}{R_s + R_p}$

$\therefore \dfrac{V_o(s)}{V_i(s)} = \dfrac{R}{R_s + R_p}$

$I_p(s) = \dfrac{V_i - V_o}{R_s}$

$V_i(s)\left(1 - \frac{1}{R_s}\right) = V_o\left(\frac{1}{sc} + \frac{1}{R_s} + 1\right)$

$\boxed{\dfrac{V_i(s)}{V_o(s)} = \dfrac{\left(\frac{1}{sc} + \frac{1}{R_c} + 1\right)}{\left(1 - \frac{1}{R_s}\right)}}$

Evaluate $V_o(t)$ when $V_i = 10\ V$, $Rs = Rp = 8K\Omega$, $Cp = 5\mu F$.

$V_o(t) = \dfrac{V_i(t) * R_p}{R_s + R_p}$ (voltage division)

$V_o(t) = \dfrac{10 * 8}{8 + 8} = \dfrac{80}{16} = 5$ Volt

$80 \div 16 = 5$

Question 2 a)state appreciable parameter variations and external disturbances encountered by a

i) a bullet (رصاصة مسدس)	Open loop	Shotter → bullet → Target
ii) a rocket.	Open loop	Shotter → Rocket → Target

0

b)The absolute value of the gain A_v of a particular common emitter amplifier is given by $A_v = \frac{Vo}{Vs} = \frac{\beta\ R_c}{r_\pi + \beta R_E}$

Represent this gain relationship as a negative feedback system. What are **G** and **H** for that system.

$$\frac{V_o}{V_s} = \frac{G}{1+GH}$$

$$\frac{V_o}{V_s} = \frac{\beta R_c / \cancel{\ }}{1 + \beta R_E / r_\pi}$$

$$\boxed{\frac{V_o}{V_s} = \frac{R_E}{1+\beta R_E / r_\pi}}$$

$\boxed{\beta R_E = R_E}$

$\therefore \boxed{G = R_E}$ $\frac{R_E}{1+\frac{R_E^2}{r_\pi}}$ X

and $\boxed{H = R_E / r_\pi}$

0

What is the sensitivity of A_v with respect of G, hence what are the conditions on the components of G in order to reduce the sensitivity?.

$$S_G^T = \frac{G}{T}\frac{dT}{dG}(A_v) = \frac{G}{T}\frac{dT}{dG}\left(\frac{\beta R_c}{r_\pi + \beta R_E}\right)$$

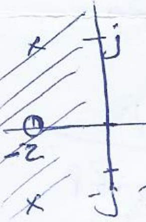
$$\Rightarrow \frac{G}{T}\frac{dT}{dG}\left(\frac{G}{1+GH}\right)$$

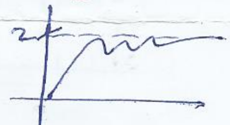
$$\frac{G}{\cancel{G/(1+GH)}} * \frac{1}{(1+GH)^2}$$

$$\therefore S_G^T = \frac{1}{1+R_E * \frac{R_E}{r_\pi}} = \frac{1}{1+\frac{R_E^2}{r_\pi}} = \frac{1}{(1+GH)}$$

1

Question 3 a)Given $Y(s) = \frac{58}{s(s^2+4s+29)}$. Calculate **y(t)** using **any** method you know.





$$Y(s) = \frac{58}{s(s^2+4s+29)}$$

$$Y_{ss}\ \lim_{t\to\infty} Y(t) = \lim_{s\to 0} sF(s) = \frac{58}{29}$$

$$= 2$$

$$\frac{58}{s(s^2+4s+29)} = \frac{A}{s} + \frac{Bs+C}{s^2+4s+29}$$

$$A(s^2+4s+29)\Big|_{s=0} = 58$$

$$A * 29 = 58$$

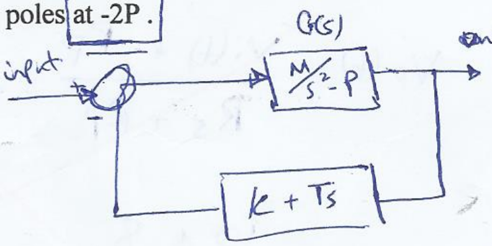
$\boxed{A=2}$ $\boxed{B=-8}$ $\boxed{C=2}$

b) A simplified transfer function of a bicycle is $G(s) = \frac{M}{s^2 - P}$ where M and P are positive numbers. Introduce whatever is needed in order to have a closed loop system with two poles at -2P.

open loop

(*) Negative

$$G(s) = \frac{M}{s^2 - P} \Rightarrow \frac{M}{(S-\sqrt{P})(S+\sqrt{P})}$$



Zero * $w_n = \sqrt{b}$

2ζω * ζ = $\frac{\cancel{\ } 9}{2\sqrt{b}}$

Zero * $W_d = w_n\sqrt{1-\zeta^2}$

1

Q3: $Y(s) = \frac{2}{s} + \frac{-8s+2}{s^2+4s+29}$

(*) $y(t) = 2u(t) + -8 * te^{-4t} + 2 * te^{-4t}$

2