EE 5340
Dec. 3, 1997
Instructor: C. Davila

Name______________________
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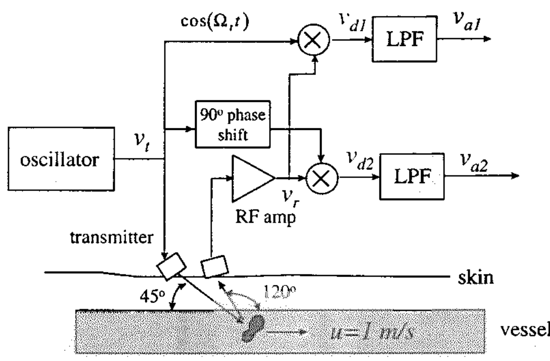
EE 5340 Exam II

1. Find expressions for v_{a1} and v_{a2}, assume $f_t = 2$ MHz: (10 pts.)



$\theta_t = 45°,\ \theta_r = 180-120 = 60°$, $c = 1570$ m/s

$V_t = \cos\Omega_t t$, $V_r = \cos(\Omega_t+\Omega_d)t$

$V_{d1} = \cos\Omega_t t \cdot \cos(\Omega_t+\Omega_d)t = \frac{1}{2}\cos\Omega_d t + \frac{1}{2}\cos(2\Omega_t+\Omega_d)t$

↓ LPF

$$V_{a1} = \frac{1}{2}\cos\Omega_d t = \frac{1}{2}\cos\left[\overbrace{\frac{-2\pi}{1570}(\cos 45° + \cos 60°)2\times10^6}^{\approx\Omega_d} t\right]$$

$$= \boxed{\frac{1}{2}\cos[9{,}661.7t]}$$

$V_{d2} = \sin\Omega_t t \cdot \cos(\Omega_t+\Omega_d)t = \frac{1}{2}\sin(-\Omega_d t) + \frac{\sin}{2}(2\Omega_t+\Omega_d)t$

↓ LPF

$$V_{a2} = -\frac{1}{2}\sin(+\Omega_d t) \doteq \boxed{\frac{1}{2}\cos(9{,}661.7t)}$$

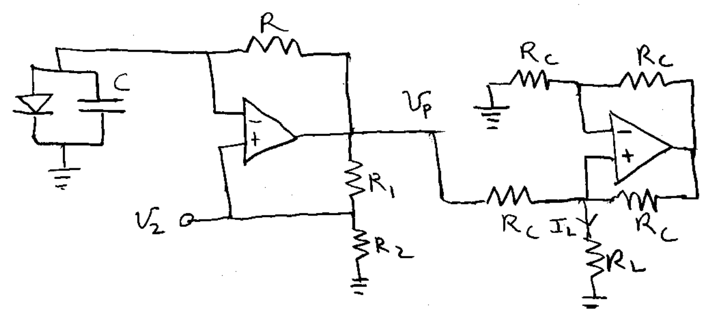
$\Omega_d \doteq 9{,}661.7$ RAD/S

$$\Omega_r = \frac{1570-\cos 60°}{1570+\cos 45°}2\times10^6$$
$$= 1.99846\times10^6\cdot 2\pi$$
$$= 12{,}556.7\times10^6$$

$\Omega_d = \Omega_r - \Omega_t = -9{,}657.4$ RAD/S

* I agree to abide by the Southern Methodist University Honor Code.

2. Design the MSMV and output circuit for an atrial synchronous pacemaker. Assume the input to the MSMV is v_2 as shown in slide 307 of the notes. The pacemaker should deliver 2 ms constant current pulses of 10 mA. Your design should include an OP amp and a comparator. The comparator output is +/- 5V. (10 pts.)



$$\tau = 2\times10^{-3} = RC\ln\left(\frac{1+V_1/V_r}{1-\beta}\right)$$

$$I_L = \frac{5}{R_C} = 10\times10^{-3}\,A$$

$$R_C = \boxed{500\,\Omega}$$

$$\ln\left(\frac{1+V_1/V_r}{1-\beta}\right) = \tau/RC$$

$$1+V_1/V_r = (1-\beta)e^{\tau/RC} = 1+0.7/5 = 1.14$$

ANY CHOICE OF R_1, R_2 + R WHICH SATISFIES WORKS

ex) $R_1 = R_2 = 10K\Omega \Rightarrow \beta = 1/2$

$$RC = \tau/\ln\left(\frac{1+V_1/V_r}{1-\beta}\right) = \frac{2\times10^{-3}}{\ln\left(\frac{1.14}{0.5}\right)}, \quad \text{PICK } \boxed{R = 10K}$$

$$C = \frac{2\times10^{-3}}{\ln\left(\frac{1.14}{0.5}\right)\times10^{4}} = \boxed{24.3\,\mu F}$$

3. In a Fleisch pneumotachometer, assume that the relation between flow and ΔP across the capillary bundle is $\Delta P = 0.1f$, where ΔP is in Pa and f is in m^3/s (assume the relationship is purely resistive). Assume that the center plate in the differential capacitor undergoes a displacement of $\Delta x = 0.5\Delta P$, where Δx is in meters. Assume the plate area and equilibrium distance of the differential capacitor is 0.1 m^2 and 0.01 m, respectively. Determine the sensitivity of the pneumotachometer in V-s/m^3. (10 pts.)

$\Delta P = 0.1 f$

$\Delta X = 0.5 \Delta P$

FROM SLIDE 76: $V_0 = V_i \left(\frac{\Delta X}{2d}\right)$, ASSUME $V_i = 1V$

OVERALL:

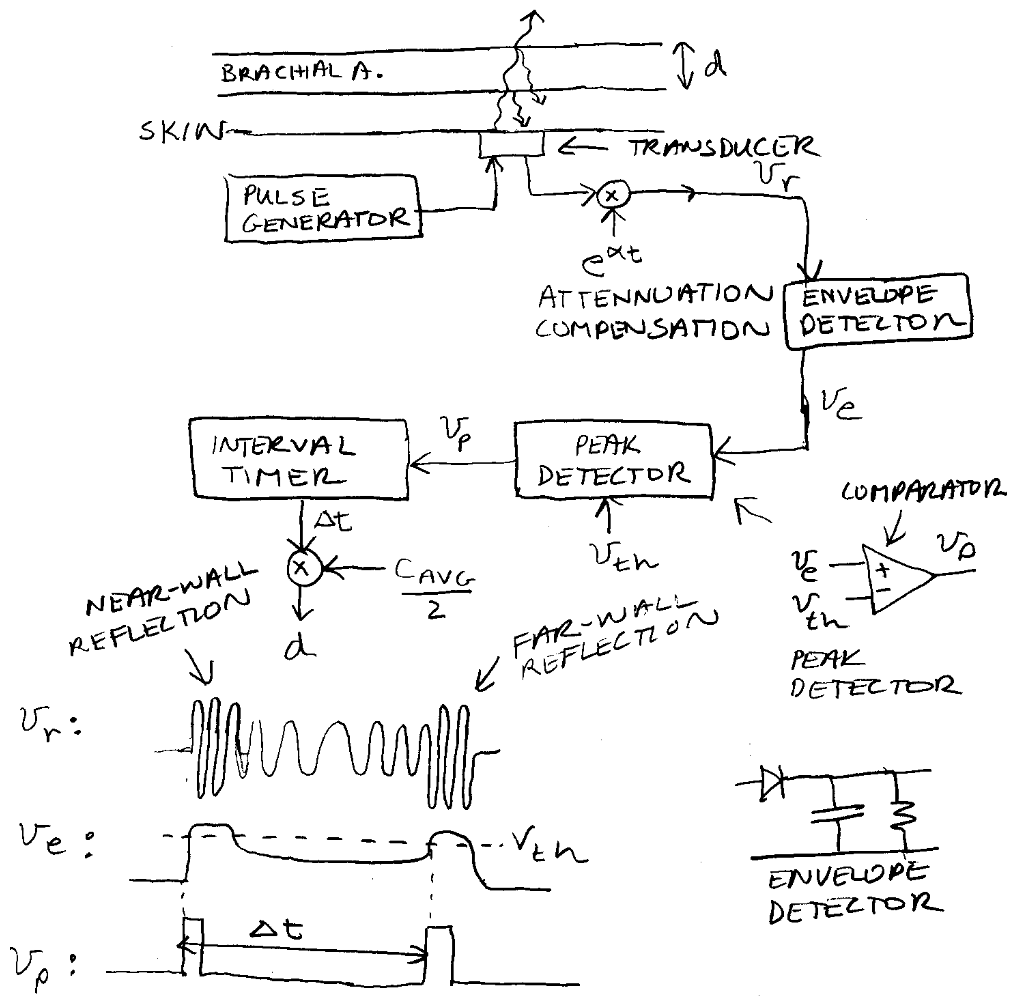
$$V_0 = \frac{1}{2d} \cdot \Delta X = \frac{0.5 \Delta P}{2d} = \frac{0.5}{2d} \cdot 0.1 f$$

$$\text{SENSITIVITY} = \frac{dV_0}{df} = \frac{0.1 \times 0.5}{2 \times d} = \frac{0.05}{2 \times 0.01}$$

$$= 2.5 \text{ V-S/m}^3$$

INDEPENDENTLY OF PLATE AREA

4. Design a device for non-invasively measuring the inner diameter of the Brachial artery in the arm. Sketch a block diagram of your design. Include all transducers used and indicate all signal processing devices necessary to generate the artery diameter in meters. Your design should be very specific. (10 pts.)



TIMER COUNTS TIME BETWEEN RISING EDGES OF V_p

C_{AVG} = AVG. SOUND VELOCITY IN TISSUE.

DIVIDE BY 2 SINCE Δt IS ROUND-TRIP TRANSIT TIME.