06-12-2017

MECE 347 Midterm

Name:

Surname:

Number:

**Q1)** The circuit below is a band-pass filter designed using two OPAMPs (Say two LM741 IC is used for this purpose. The circuit parameters are given as RX=10 MΩ, RY=10 MΩ, R1=R2=1 MΩ, C1=1 μFarad, C2=0.0625 μFarad.



1. For the circuit above Vin is the input Vout is the output. Show that the transfer function of this circuit in Laplace domain is $H\left(s\right)=\frac{V\_{out}(s)}{V\_{in(s)}}=\frac{4s}{(s+16)(s+1)}$ **(20 points)**
2. Show that the resonant angular frequency of this circuit is wr=4 rad/sec. **(5 point)**
3. Show that the exact cut of frequencies of the circuit are found by the polynomial equation

 $w\_{c}^{2}\pm 17w\_{c}-16=0$, where wc stands for the cut-off angular frequencies. **(10 point)**

1. **The exact cut-off angular frequencies should be found to be equal to wc2=17.894 rad/sec and wc1=0.894 rad/sec.** Now we want to draw the bode-plot of this band pass filter and instead of the exact cut-off angular frequencies let us approximate $w\_{C1}≅1$ rad/sec and $w\_{C2}≅16$ rad/sec. Use the magnitude response $\left|H(jw)\right|\_{Db}=20 log⁡(\frac{4w}{\sqrt{w^{2}+16^{2}}\sqrt{w^{2}+1^{2}}})$ in Db (decibels), and draw the approximate magnitude response in logarithmic scale. **(15 point).**

**Hint:** In Laplace domain the impedance of a resister R is XR = R Ω, the impedance of a capacitor C is $X\_{C}=\frac{1}{sC}$ Ω.

**Q2)** Design an OPAMP circuit which solves the differential equation $\frac{d^{2}}{dt^{2}}V\_{out}+V\_{out}=V\_{in}$. In your circuit only use inverting amplifiers, differentiators and summing amplifier. **(20 point)**

**Q3)** For the circuit below the input resistance of the amplifier is $R\_{in}=\frac{V\_{in}}{I\_{1}}$, the gain of the amplifier is $A\_{v}=\frac{V\_{out}}{V\_{in}}$. A capacitor having an impedance of XC is connected between the input and output stage as below. What is the total impedance $Z\_{in}=\frac{V\_{in}}{I\_{in}}$ seen from the input stage of this circuit? **(10 points)**



**Q4)** A FET amplifier structure in small signal AC analysis is given below. This circuit is examined for low frequency range and it should have 3 cut of frequencies due to the capacitors Cg, Cd and Cs. Find approximately the cut-off frequency due to capacitor CS. In the calculations take r0=RL=RD=RS=1000 Ω, CS= 1 μFarad, gm=10-3 Siemens. **(20 points)**

