EECS145L, Fall 1999 (9/29/99)
Midterm #1 Solutions
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Problem #1

a)
The op-amp equation is V0 = A(V+ - V-)
If V0 is finite and A is infinite, then V+ = V- (virtual short rule)
V- = V+ = V2R2/(R1+R2)
Since no current flows in or out of the op-amp inputs
(V+ - V1)/R1 + (V+ - V0)/R2 = [V+(R1 + R2) - V1R2 - V0R1]/R1R2 = (V2R2 - V1R2 -
(V2 - V1) / R1 = V0/R2
G[+or-] = V0/(V2 - V1) = R2/R1

b)
To determine common mode gain, set V1 = V2 in the equation (V2 - V1)/R1 = V0/R2

Problem #2

4nV*Hz^(-1/2)*SQRT(Delta(f)) = 1.28x10^(-10)*OMEGA^(-1/2)*Hz^(-1/2)*SQRT(R*Delt
SQRT(R) = 40/1.29
R=961 Ohms

Problem #3

a)
Differential gain 1000, bandwidth 10kHz
[3 points off for Gain = 10,000, bandwidth 1kHz]

b)
Output Vrms = (4nV*Hz^(-1/2))(100*Hz^(-1/2))(1000) = 0.4mV in 10kHz = noise to
[2 points off for 0.4 microV]

c)
We want a Butterworth low-pass filter with a gain of 0.99 at 1kHz and 0.01 at 2
The order is 10 and the corner frequency is 1/0.823 = 1.22kHz. (order 12 also a
[5 points off for not giving corner frequency]
[2 points off for not specifying low pass]
[2 points off for order 8]
After amplification and filtering, the output noise would be Vrms = (4nV*Hz^(-1
[4 points off if output noise not given]
So the filtering reduce the output noise from [+or-]0.4mV to [+or-]0.14mV

d)

The best way to reduce the 60Hz interference from the middle to a band of frequ
[Any value between 0.1 and 2mV was accepted for full credit]
[3 points off for including one 10mV and not the other]
[6 points off if input noise not given]
[10 points off for using a HPF, which removes the important earthquake frequenc

e)
Seismometer followed by a instr amp of gain 1000, followed by a notch filter (6

145L midterm #1 grade distributions:

Problem	
1	32.5 (35 max)
2	9.7 (10 max)
3	47.3 (55 max)

maximum score = 100
average score = 89.4

66-77	0	
71-75	1	
76-80	4	C
81-85	1	
86-90	3	B
91-95	4	B
96-100	6	A