Union College
ECE248 Spring 2018
Final Exam Take Home Questions

Name:_____

The final exam will be in two parts and all students must complete both parts of the exam. The two parts are:

1. The take home part, which is given below, must be done individually. However you may use your textbook, class notes, and also ask me for help. This part of the exam is due at the classroom part of the exam Tuesday June 12 from 8:30 to 10:30.
2. The in-class part which will be given during finals week.

I have not discussed this exam with anyone and have not received or given assistance to anyone concerning this exam.

Signature:_____

Notes:

1. Answer all parts of all questions and show all work.
2. Hand in all requested Multisim simulations with schematic diagram and outputs. Make sure to label all graphs completely (axis, title, units etc).

Problem 1: Multistage Amplifier (25 pts)

Consider the two-stage amplifier given in Figure 1 below. The supply voltage is V_{CC} = +15 V, the load is R_L = 560 Ω and the source impedance (generator) is R_S = 5600 ohm. Both transistors have a β of 100.

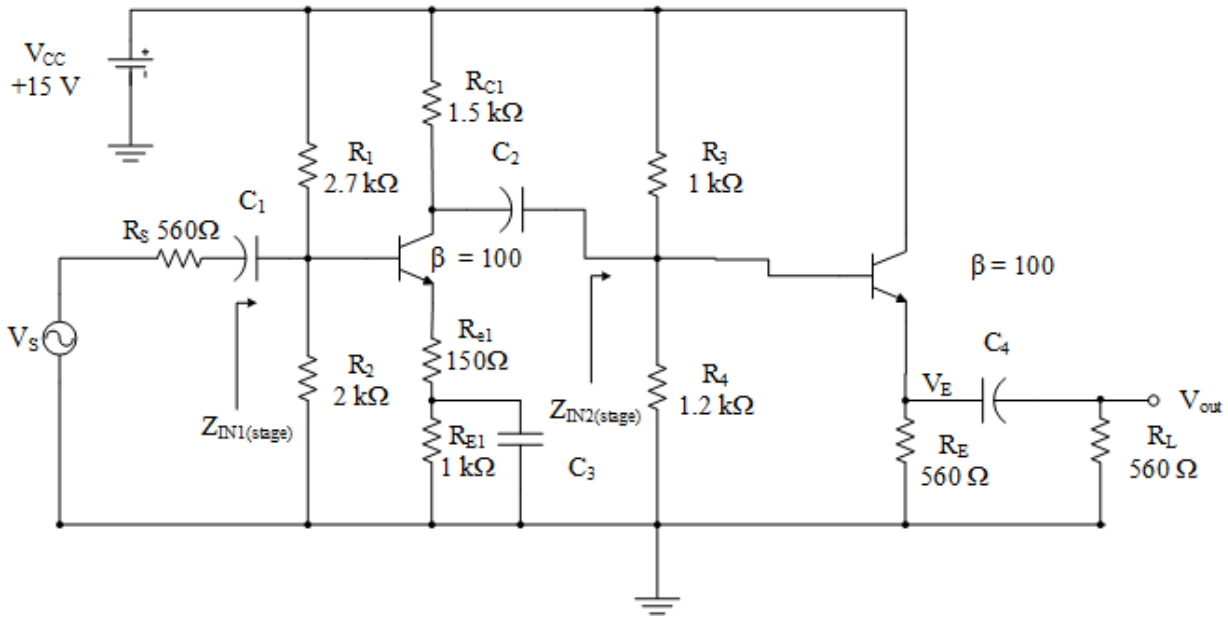

Figure 1

(a) Compute the gain Av_2 and input impedance $Z_{IN2(stage)}$ of the second stage.

(b) Compute the gain A_1 and input impedance $Z_{IN1(stage)}$ of the first stage.

(c) Draw the ac-equiverent circuit for the entire amplifier (both stages).

(d) Calculate the gain of the entire amplifier $A_v = V_{out}/V_s$

(e) If the input signal V_S is a 200 mV_{PP} sine wave at 2 kHz, sketch both V_S and V_{OUT} over a 1 ms interval. Label important features including the phase relationship between the input and output signals.

(f) Calculate values for C1, C2, C3, and C4 for a frequency range of 20 Hz to 20 kHz (see pages 282 and 283 in the textbook). Use the closed standard capacitor value given in the table at the end of this exam.

(g) Calculate the RMS output power delivered to R_L 200 mV_{PP} sine wave at 2 kHz.

(h) Simulate the multistage amplifier in Multisim. Do the following:

a. Simulate the input and output wave forms with the input set to 200 mV_{PP} sine wave at 2 kHz. And use this to calculate the voltage gain. How close is this to the theoretical voltage gain. Print out the circuit and wave forms and hand them in with this part of the exam.
b. Run an AC sweep analysis from 1 Hz to 100 kHz, printout the frequency response and hand them in with the exam. Find the 3 dB low frequency cutoff.

Problem 2: Maximum Undistorted Output (MUD) (15 pts)

Consider the common emitter voltage amplifier shown in Figure 2 below. Assume every capacitor is sufficiently large to be a perfect short at signal frequencies.

(a) Compute the Q-point to give Maximum Undistorted Output (MUO).

(b) Compute the value for R_2 to give the Q-point calculated in part (a).

(c) Draw the DC and AC load lines. Label them completely.

(d) Calculate the MUD using the load lines.

(e) Let V_S be a $0.6V_{PP}$ sine wave at 2 kHz. Sketch both V_S and V_{LOAD} over a 2 ms interval. Make sure to label important features!

(f) Simulate the amplifier using Multisim and find the MUD. Run and print out the Operating Point analysis for V_{CEQ} and I_{CQ}. Compare these with the calculated values. Print out the schematic and output waveform at MUD and compare with your calculated values.

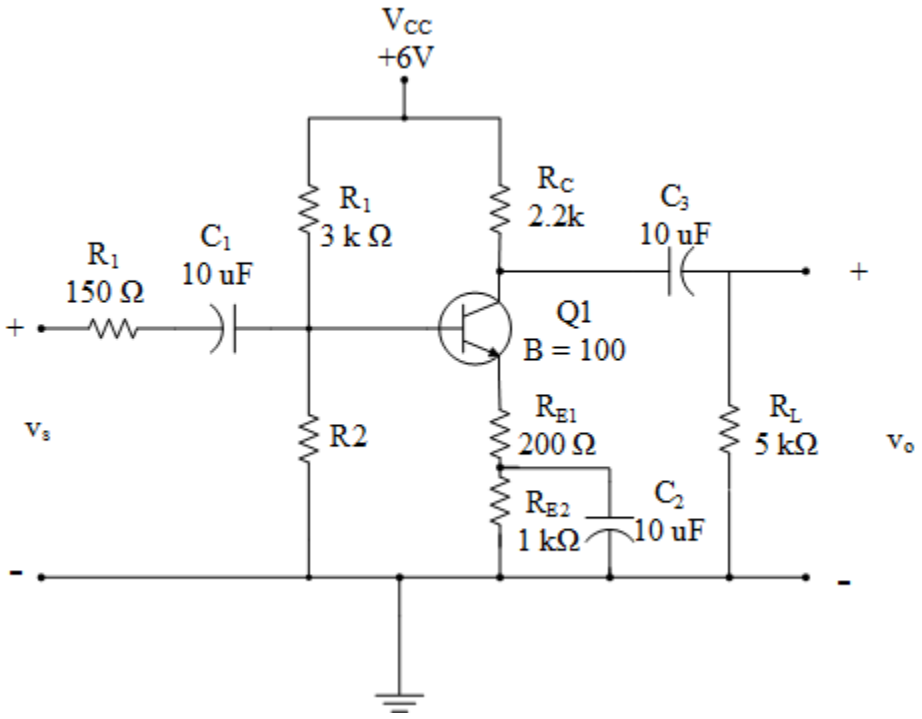

Figure 2

Standard Resistor Values (±5%)						
1.0	10	100	1.0K	10K	100K	1.0M
1.1	11	110	1.1K	11K	110K	1.1M
1.2	12	120	1.2K	12K	120K	1.2M
1.3	13	130	1.3K	13K	130K	1.3M
1.5	15	150	1.5K	15K	150K	1.5M
1.6	16	160	1.6K	16K	160K	1.6M
1.8	18	180	1.8K	18K	180K	1.8M
2.0	20	200	2.0K	20K	200K	2.0M
2.2	22	220	2.2K	22K	220K	2.2M
2.4	24	240	2.4K	24K	240K	2.4M
2.7	27	270	2.7K	27K	270K	2.7M
3.0	30	300	3.0K	30K	300K	3.0M
3.3	33	330	3.3K	33K	330K	3.3M
3.6	36	360	3.6K	36K	360K	3.6M
3.9	39	390	3.9K	39K	390K	3.9M
4.3	43	430	4.3K	43K	430K	4.3M
4.7	47	470	4.7K	47K	470K	4.7M
5.1	51	510	5.1K	51K	510K	5.1M
5.6	56	560	5.6K	56K	560K	5.6M
6.2	62	620	6.2K	62K	620K	6.2M
6.8	68	680	6.8K	68K	680K	6.8M
7.5	75	750	7.5K	75K	750K	7.5M
8.2	82	820	8.2K	82K	820K	8.2M
9.1	91	910	9.1K	91K	910K	9.1M

Standard Capacitor Values (±10%)						
10pF	100pF	1000pF	.010µF	.10µF	1.0µF	10µF
12pF	120pF	1200pF	.012µF	.12µF	1.2µF	
15pF	150pF	1500pF	.015µF	.15µF	1.5µF	
18pF	180pF	1800pF	.018µF	.18µF	1.8µF	
22pF	220pF	2200pF	.022µF	.22µF	2.2µF	22µF
27pF	270pF	2700pF	.027µF	.27µF	2.7µF	
33pF	330pF	3300pF	.033µF	.33µF	3.3µF	33µF
39pF	390pF	3900pF	.039µF	.39µF	3.9µF	
47pF	470pF	4700pF	.047µF	.47µF	4.7µF	47uF
56pF	560pF	5600pF	.056µF	.56µF	5.6µF	
68pF	680pF	6800pF	.068µF	.68µF	6.8µF	
82pF	820pF	8200pF	.082µF	.82µF	8.2µF	