ICS 2200 REVISION QUESTIONS

1) What is the resistance of a nichrome wire 1mm in diameter and 1m in length? For nichrome, $\rho = 100 \times 10^{-8}\ \Omega m$ at 300K. (ANS 1.27Ω)
2) For an sinusoidal AC source delivering voltage vs and current is:
   a) Show that the average power dissipated for a purely resistive load is $V_{SRMS} I_{SRMS}$.
   b) Show that the average power dissipated for a load with resistance and reactance is $V_{SRMS} I_{SRMS}$COSφ, where φ is the phase difference between voltage and current.
   c) Show that the average power dissipated in a purely capacitive load is zero.
   d) Show that the average power dissipated in a purely inductive load is zero.
3) An electric heater connected to a 240-V source consists of two identical 0.8-Ω elements made of Nichrome wire. The elements provide low heat when connected in series and high heat when connected in parallel. Assuming the heater operates at a temperature of 300K, evaluate:
   a) The length of wire in each heating element. (For nichrome, $\rho = 100 \times 10^{-8}\ \Omega m$ at 300K and $\alpha = 0.0004$ per °C at 20°C)
   b) The power dissipated at low heat and high heat settings.
   c) Repeat (a) and (b) for an operating temperature of 1500K.
4) A sine wave with amplitude 20Vpp is connected to a 10 kΩ resistor. Calculate the peak, the rms, and the average currents though the resistor. What power rating should the resistor have to avoid damage?

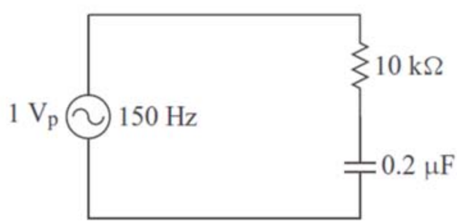


Figure Q5

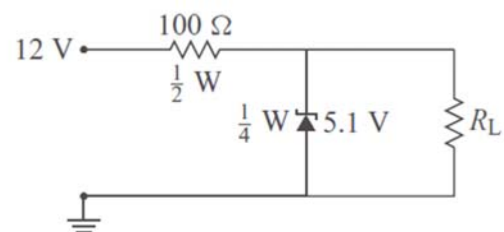


Figure Q8

5) Calculate the magnitude and the phase of the total impedance for the circuit in Figure Q5. (ANS magnitude 11.3 kΩ, phase −27.95 degrees)
6) Suppose we change the frequency of the signal generator in the circuit of Q5. If the angular frequency is set to 103 rad/s, what is the peak amplitude of the voltage across the capacitor? Of the voltage across the resistor?
7) Sketch the energy band configuration for a p-n junction under the following conditions: no bias, reverse bias, and forward bias. On each, indicate the direction of the net current.
8) In the circuit in Figure Q8, (Hint: think in terms of power ratings.)
   a) What would happen if the load resistor were shorted? (ANS: If R_L is shorted, the power into the ¼W resistor is 1.44W, so the resistor burns out)
   b) What would happen if the load resistor were removed? Support your answers with calculations.

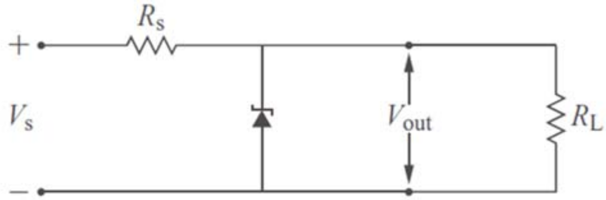


Figure Q9

9) In the Zener diode voltage regulator shown in circuit of Figure Q9:

a) Determine the range of load resistances over which the circuit gives a constant V_{out} if R_s = 1500Ω and V_s = 150 V. Assume the diode breakdown voltage is 100 V and the maximum rated current is 100 mA. (ANS: Circuit gives a constant V_{out} for R_L > 3 kΩ)

b) If R_L is fixed at 10 kΩ, over what range of input voltages does the circuit regulate?

10) Let V_s = 30 V, R_s = 300Ω, and the Zener breakdown voltage be 15 V in the circuit of Q9. Suppose we vary the load resistor R_L in order to vary the current through R_L (the load current). Plot the output voltage of the regulator as a function of load current from 0 to 75 mA. Over what load current range is the regulator effective?

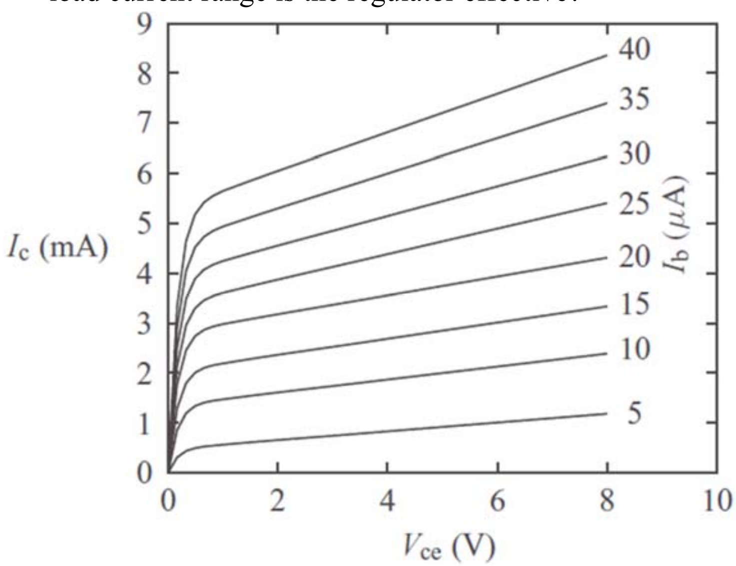


Figure Q11

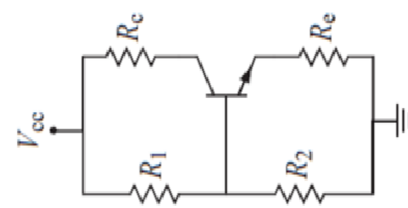


Figure Q12

11) Using the transistor characteristics in Figure Q11, find β for several values of Ib when Vce = 6V. Repeat for several values of Vce when Ib = 30 μA. This shows that β is not really a constant over the linear active region.

12) Determine the operating point of the transistor DC bias circuit of Figure Q12 when V_{CC} = 15 V, R_1 = 10 kΩ, $R2$ = 2.2 kΩ, R_C = 680 Ω, and R_E = 100 Ω. Assume β = 200 and V_{BE} = 0.72 V. (ANS: I_B = 90.4μA, I_C = 18.1 mA, V_{CE} = 0.873 V)

13) Design a circuit that will set a reasonable operating point for a transistor with the characteristics of Figure Q11. Assume that the power rating for the transistor is 25 mW.

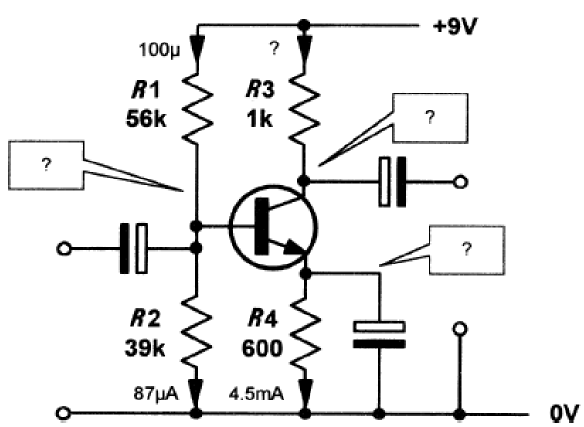


Figure Q14

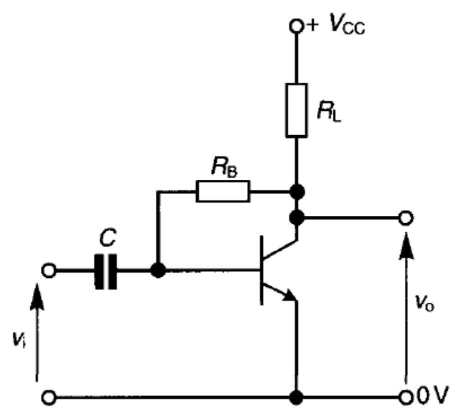


Figure Q15

14) Determine the unknown voltages and currents in the Figure Q14. (ANS: 13μA, 3.39V, 2.7V, 4.51V)

15) For the BJT biasing circuit of Figure Q15 above:

a) Calculate the resistor values for a collector operating current of 1mA, Collector voltage of 5V, supply voltage of 10V and β = 100.
b) If the transistor is replaced by one with β = 200, confirm that the operating point will change to V_{CE} = 3.3V and I_C = 1.33mA

16) Suppose an amplifier has an open-loop voltage gain of 20, an input impedance of 100 Ω, and an output impedance of 50 Ω. The amplifier is driven with a sinewave generator with output impedance of 50 Ω and an open loop amplitude of 0.1 Vpp. Find the resulting voltage across a 200 Ω load attached to the amplifier output. (ANS: 1.067 Vpp)

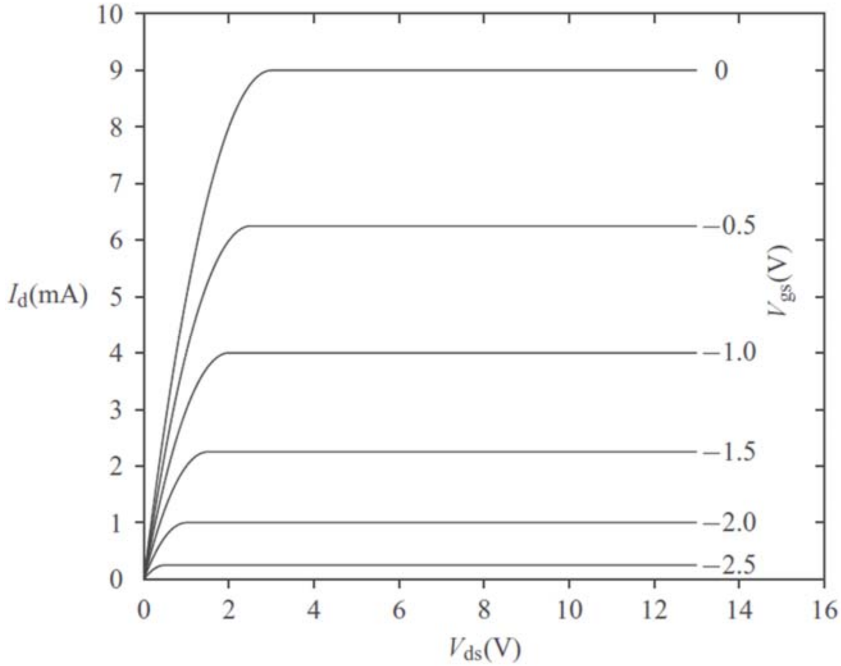


Figure Q17

17) Consider the transistor characteristics in Figure Q17. (ANS: K = 1 mA/V2, Vt = −3 V)
a) Are these the characteristics of a JFET, d-mosfet, or e-mosfet?
b) Make a table of the given *V*gs values and the corresponding *I*d(sat) values. Also include a column in the table giving √(*I*d(sat)).
c) Make a plot of √(*I*d(sat)) versus *V*gs. Find the slope and *y*-intercept of the plot and use these to determine values for *K* and *V*t in the model equation.

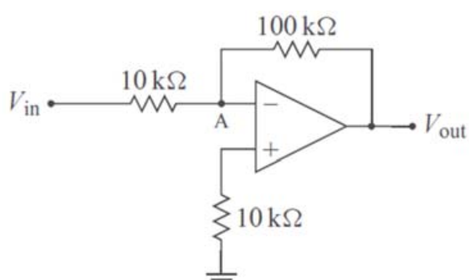


Figure Q18

18) For the circuit in Figure Q18, find V_{out} as a function of V_{in} and determine the input impedance of the circuit.
19) For each of the circuits in Figure Q19, determine the output voltage. Assume $\pm V_{sat} = \pm 10$ V.
20) Draw the schematic diagram of an inverting amplifier with R_i = 5 kΩ and a voltage gain of −75.

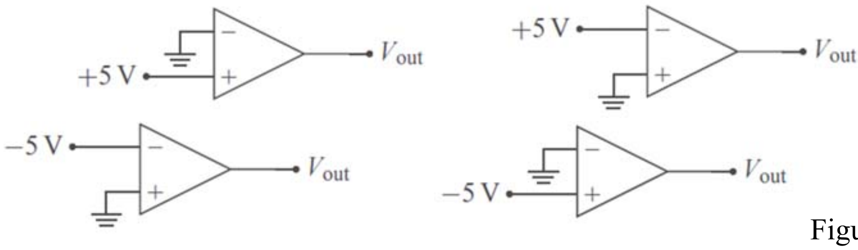


Figure Q19

21) If the circuit of Q20 uses ±12 V power supplies, what input voltage will cause the output to saturate? (ANS: 147 mV)

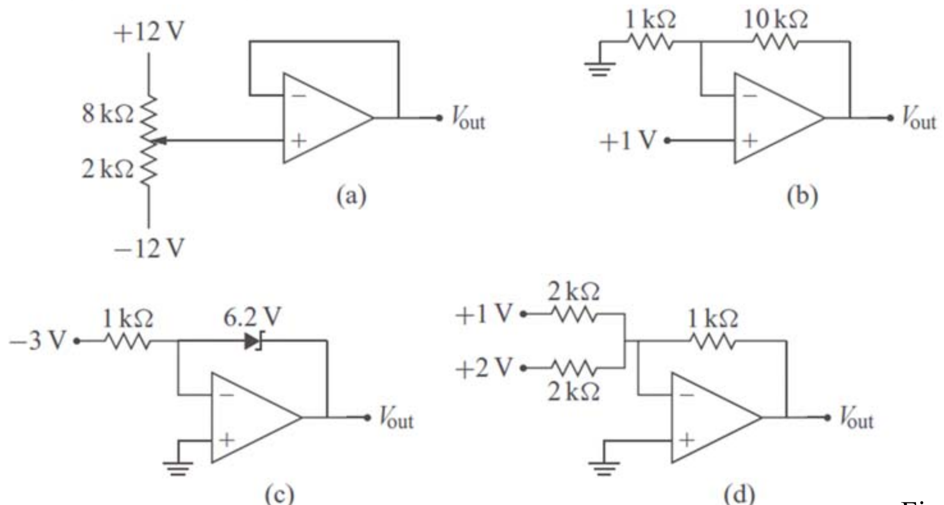


Figure Q22

22) Determine the output voltage for each circuits in Figure Q22. (ANS(a): Vout = −7.2 V)

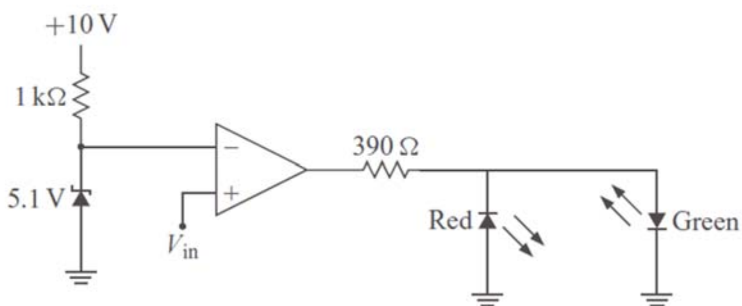


Figure Q23

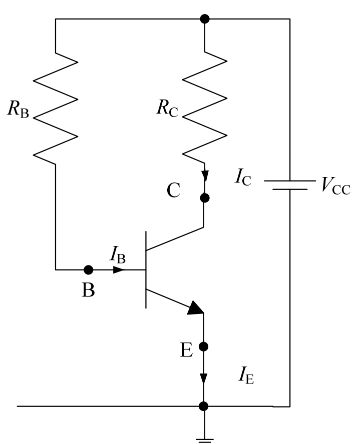


Figure Q25

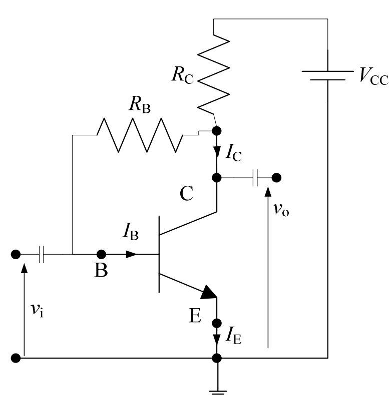


Figure Q26

23) Explain the operation of the circuit in Figure Q23 as V_{in} is varied.

24) For the circuit of Figure Q12, V_{CC} = 12 V, R_1 = 60kΩ, R_2 = 12kΩ, R_C = 15kΩ and R_E = 10kΩ. Assume β = 50 and V_{BE} = 0.6 V.

a) Determine the quiescent values of I_C and V_{CE}. (0.135mA, 8.6V).
b) Repeat (a) if $\beta = 20$. (0.127mA, 8.76V).
c) Repeat (a) if $\beta = 125$. (0.138mA, 8.54V).

25) For the circuit of Figure Q25, $V_{CC} = 60V$, $R_B = 6k\Omega$, and $R_C = 30\Omega$. Assume $V_{BE} = 0.7V$.
a) What is the value of β if the quiescent values of $I_C = 1.15A$ and V_{CE}.= 25V. (116?).
b) What is the power dissipated in the transistor?
c) What is the total power supplied by V_{CC}? (69.6W)
d) What will be the quiescent values if $V_{CC} = 50V$, $R_B = 8k\Omega$, and $R_C = 20\Omega$.

26) For the circuit in Figure Q26, $V_{CC} = 9V$, $\beta = 100$ and $V_{BE} = 0.6V$. The operating point has $I_C = 5mA$ and $V_{CE} = 5V$ [10 Marks]
a) Explain the purpose of the capacitors connected at v_i and v_o.
b) Determine the values of resistors R_B and R_C.
c) Determine the values of resistors R_B and R_C if the transistor has $\beta = 50$.

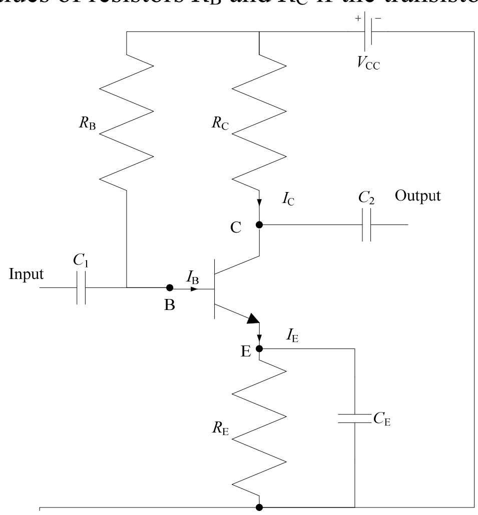
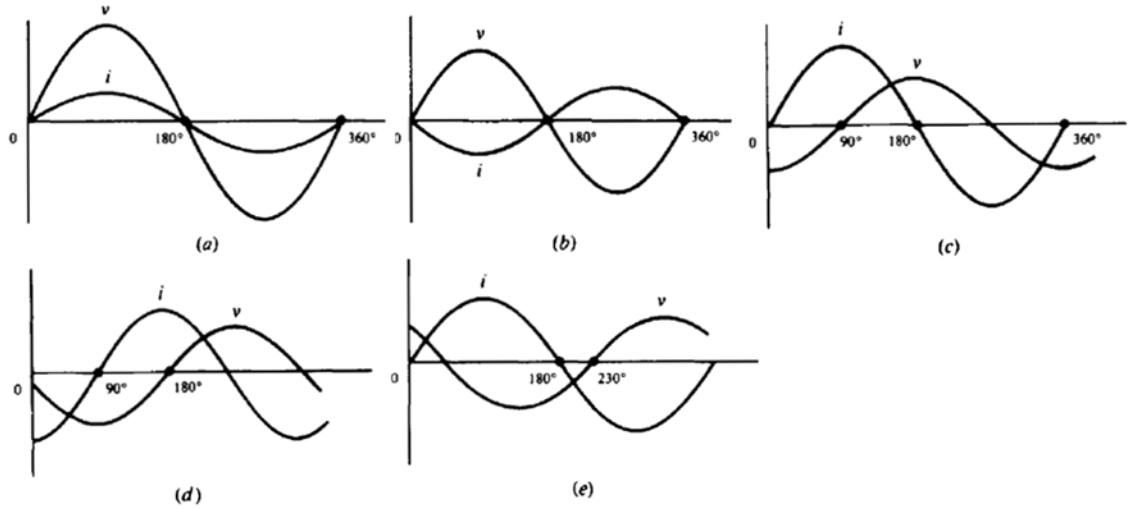


Figure Q27

27) For the circuit in Figure Q27, $V_{CC} = 15V$, $R_B = 280k\Omega$, $R_C = 1k\Omega$, , $R_E = 2k\Omega$, $\beta = 100$ and $V_{BE} = 0.6V$. [10 Marks]
a) Explain the purpose of the capacitors C_1 , C_2 and C_E.
b) Determine the quiescent values of I_C and V_{CE}.
c) Determine the quiescent values if the transistor has $\beta = 200$.

Revision Questions Alternating Current:



1) For the waveforms below, indicate the phase angle (in degrees and radians) between the voltage and current. Indicate which quantity is leading and which is lagging.
2) A 4Ω heater is connected to the 240V ac power source by two 50m lengths of copper wire of cross-sectional area 1.5mm^2. The resistivity of copper is 1.68×10^{-8} Ω-m. Sketch the circuit and calculate the following:
    a. The total length of wire that connects the 8Ω heater to the 240Vac power source.
    b. The resistance of the connecting wires and the total resistance, R_T, of the circuit.
    c. The current, I, in the circuit.
    d. The voltage drop across each 50m length of copper wire.
    e. The voltage across the 8Ω heater.
    f. The I^2R power loss in each 50m length of copper wire.
    g. The power dissipated by the 8Ω heater.
    h. The total power, P_T, supplied to the circuit by the 240Vac power line.
    i. The percentage of the total power, P_T, dissipated by the 8Ω heater.
3) Recalculate the values in steps a through to i if the 1.5mm^2. wires are replaced by 2.5mm^2.
4) Recalculate the values in steps a through to i if the 8Ω heater is replaced with a 24Ω fan.
5) The peak voltage of an ac sine wave is 100 V. (a) Find the instantaneous voltage at 0,30,60,90, 135, and 245°. (b) Express the angles in radians (in terms of π). (c) Plot these points and draw the sine wave voltage.
6) If an ac voltage wave has an instantaneous value of 90V at π/6 radians, find the peak value.
7) An ac wave has an RMS value of 50mA. Find the peak value and the instantaneous value at π/3 radians

Revision Questions – Conduction in Semiconductors:

1) What are two other names for depletion zone?
2) Can a silicon diode be forward-biased if the anode voltage is negative? Explain your answer.
3) Explain why a bridge rectifier would be used instead of a two-diode full-wave rectifier.
4) Explain why the Zener current and load current variations in a loaded Zener regulator are equal but opposite.

5) Explain the following terms for a P-N diode: (a) Forward bias; (b) Reverse bias.
6) Explain the process of: (a) Zener breakdown; (b) Avalanche breakdown.
7) Which type of breakdown is applied deliberately in an electronic device?

Revision Questions Op Amps:

1) What is a common-mode signal?
2) What is the common-mode rejection ratio and how is it usually specified?
3) What are the advantages of using negative feedback with an amplifier?
4) Explain the concept called virtual ground.
5) Why is a Schmitt trigger immune to erratic triggering caused by noise?
6) Draw the block diagram of operational amplifier, labelling all the terminals.
7) For an amplifier, explain the terms: (a) input impedance; (b) output impedance; (c) Voltage gain.
8) For the inverting amplifier given that R_1=1kΩ and R_F=10kΩ. Assuming an ideal op amp, calculate the output voltage for the input of 1V.
9) For the non-inverting amplifier given that R_1=1kΩ and R_F=10kΩ. Assuming an ideal op amp, calculate the output voltage for the input of 1V.
10) Sketch the circuit of op amp: (a) Inverting amplifier; (b) Non-inverting amplifier; (c) Inverting summer with 3 inputs.
11) Derive the expression for voltage gain for op amp: (a) Inverting amplifier; (b) Non-inverting amplifier; (c) Inverting summer with 3 inputs.
12) Sketch the circuit and explain the working of a precision rectifier.
13) What are the possible applications of comparators and Schmitt triggers? Why would a Schmitt trigger be preferred to a comparator?
14) For a Schmitt trigger, explain the term hysteresis or ‘dead zone’.