

You may use one sheet of notes and your calculator. Fill in the blanks, circle the correct answer, etc.

1. (93) Quickies

- a) A "220 Ω resistor" with a tolerance of 10% may have an actual resistance as high as _____ Ω .
- b) We have treated capacitors, inductors, and resistors as though they are ideal devices. Which is the least ideal? _____
- c) Industrial users of electric power pay a (an) _____ charge based on the peak use of power over a designated period.
- d) Three-phase distribution frequently uses 12,470 V as the line-to-line voltage. What is the line-to-ground voltage? _____
- e) Three-phase motors are usually (delta-, Y-, star-) connected.
- f) A high-pass filter has a gain of .35 at 1000 Hz. What is its gain in dB at 1000 Hz? _____ dB
- g) Two amplifiers are connected together. The first has a gain of 12 dB. The second has a gain of -4 dB. The net gain is _____ dB.
- h) A high pass filter has a cutoff frequency of 100 Hz. If a low resistance load is attached to the output of this filter, the cutoff frequency will (increase, decrease, remain the same).
- i) What is $1001\ 0101_2$ in decimal? _____
- j) RAM memory is _____, meaning that the data is lost when the power is shut off.
- k) Which memory technology requires refresh? _____
- l) _____ devices are frequently used to make buses.
- m) Fast _____ memory buffers data between the microprocessor and main memory to speed up access.
- n) If a D flip-flop has a logic 1 at its data input, and a clock pulse arrives at the flip-flop's trigger input, the Q output will become logic _____.
- o) An amplifier has its 3 dB points at 1 kHz and 5 kHz. The bandwidth of the amplifier is _____ kHz.
- p) A properly terminated 10 m long piece of coax cable has an impedance of 75 Ω . A 100 m long piece of properly terminated coax cable will have an impedance of _____ Ω .
- q) Which rechargeable battery type that we studied has the highest energy density? _____

r) Which of the light bulb types that we studied has the highest efficiency? _____

s) We studied cabling choices for connection to sensors in high-noise environments. Name the cabling choice that was recommended for single-ended amplifiers. _____

t) What is the most common device used for power factor correction? _____

u) Ventricular _____ can be caused by current flowing through the heart.

v) Give the colors of these wires found in residential wiring:

Name	Color
Hot (120 V)	_____
Return (neutral)	_____
Ground	_____

w) A (an) _____ voltage regulator is power-efficient and may have several different voltage outputs.

x) What type of battery is typically used in a laptop computer? _____

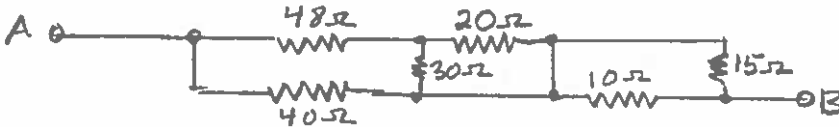
y) A (an) _____ is frequently connected between two amplifier stages to block DC offset voltages.

z) How much charge flows through a resistor carrying a current of 50 mA for 2 minutes? _____ C

aa) An NPN BJT has a β of 20. Its base current is 3 mA. Its collector current is _____ mA. Its emitter current is _____ mA.

bb) The current through what basic passive device cannot be changed instantaneously? _____

2. (15) $R_{AB} =$ _____. The answer is an integer.



3. (15) An 8-bit A/D converter has $V_{ref+} = 7\text{ V}$ and $V_{ref-} = -1\text{ V}$. The analog voltage in is 1.9 V. The binary output of the A/D converter is _____. The analog voltage contains frequencies between 450 Hz and 4000 Hz. The minimum sampling rate of the A/D converter should be _____ samples/s.

4. (40) $i = 50 \cos(40t - 37^\circ) \text{ A}$

$I_{\max} =$ _____

$I_{\min} =$ _____

$I_{\text{avg}} =$ _____

$I_{\text{peak-to-peak}} =$ _____

$I_{\text{rms}} =$ _____

Phasor $\mathbf{I} =$ _____

$i(t=1) =$ _____

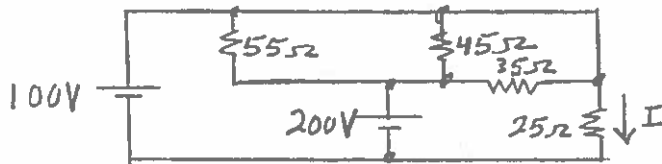
$\omega =$ _____

$f =$ _____

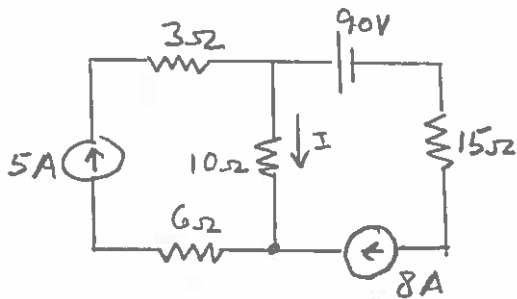
$T =$ _____

Average power consumed in a 5Ω resistor connected to this source = _____

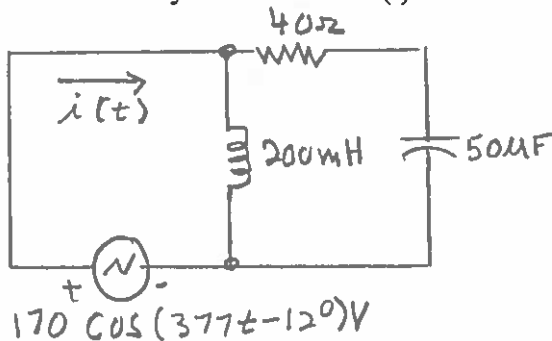
5. (10) $I =$ _____ (The answer is an integer)



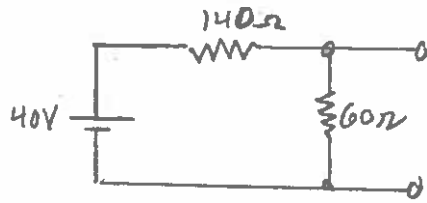
6. (10) $I =$ _____ (The answer is an integer)



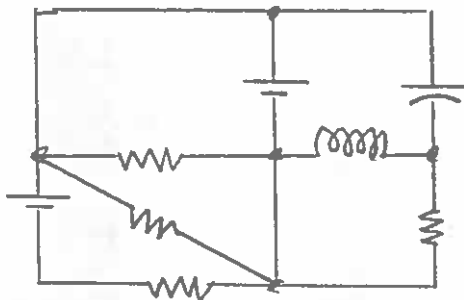
7. (30) Find the steady state value of $i(t)$. Sketch and label appropriate circuits.



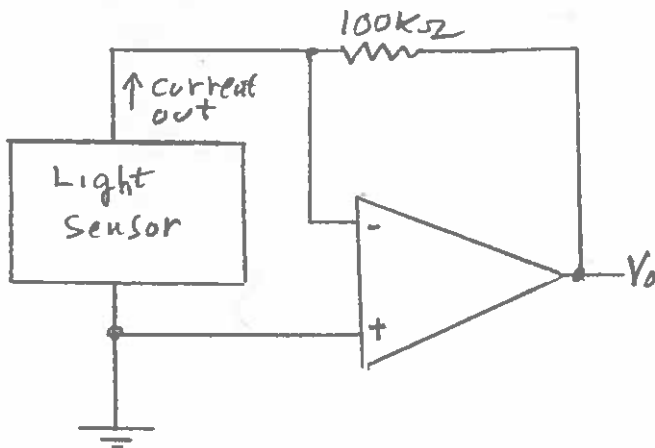
8. (20) Draw and label the Thevenin equivalent circuit.



9. (15) Circle the essential nodes in the circuit below. There are _____ KCL equations needed. There are _____ KVL equations needed.



10. (30) The light sensor acts like a current source. It puts out 0 A in the dark. In bright sunlight it puts out $50 \mu\text{A}$. The op amp is ideal. Label the diagram. Carefully show your analysis. Find V_o for darkness. Find V_o for bright sunlight.



11. (30) For each of the applications below, select the most appropriate motor type from the following list: Brushless DC, 3 ϕ induction, 1 ϕ induction, permanent magnet, series (universal), shunt, stepper, 3 ϕ synchronous, 1 ϕ synchronous, variable reluctance.

50 hp, industrial fan motor: _____

Industrial motor used for power factor correction: _____

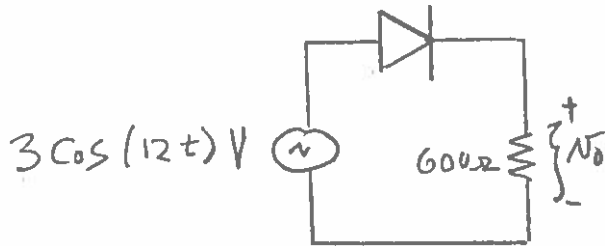
Hand-held tool able to handle a wide range of torques and speeds: _____

Motor for a toy car: _____

Industrial motor requiring constant speed, regardless of load: _____

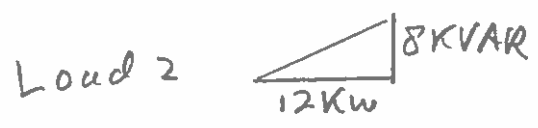
Motor for a computer disc drive head: _____

12. (15) The diode is made of silicon. Sketch and label v_o as a function of time. Find the maximum forward current.

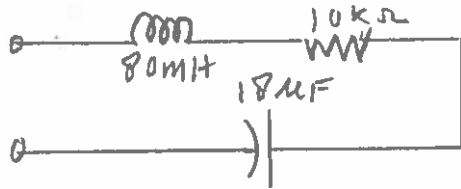


13. (15) Transformer nameplate data is as follows: "Pri. 240 V, 60 Hz, Sec. 48 V, 18 VA." This transformer is plugged into a 240 V, 60 Hz source, and the output terminals are connected to a 150 Ω resistor. Sketch and label the circuit. What is the current in the 240 V source?

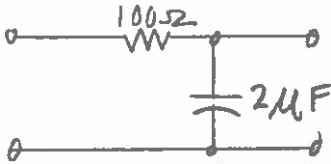
14. (15) A shop is fed by single-phase 120 V AC power. The power triangles of two industrial loads are shown below. Find the net current feeding the two loads.



15. (5) The resonant frequency of the circuit below is _____ Hz.



16. (15) The filter below is a (band pass, high pass, low pass, notch) filter. At a frequency of 500 Hz its gain is _____.



17. (10) A certain motor is rated at 40 hp at 2800 rpm. What is its torque?

18. (10) A Li-ion 3.6 V battery is rated at 5000 mAh. How long will it last when connected to a $20\text{ }\Omega$ resistor?

19. (10) A certain microphone can be modeled as a 12 mV rms source in series with a $1\text{ M}\Omega$ resistor. It is used to feed an audio amplifier with a gain of 50 dB and an input impedance of $500\text{ k}\Omega$. What is the output voltage of the amplifier?

20. (10) The current in an initially uncharged $10\mu\text{F}$ capacitor is $12 + 5e^{-6t}$ A. Find the voltage across the capacitor as a function of time.

21. (5) Sketch and label a basic MOSFET.

22. (15) You have a 9 V battery, an assortment of resistors, and two LEDs, each with a forward voltage drop of 3.5 V and a maximum average current of 20 mA. You want to make a circuit that lights these diodes to their maximum brightness. Sketch and label the circuit. Determine the correct resistor value.

23. (15) A three-phase delta-connected motor has a phase voltage of 460 V and a phase current of 33 A. Its power factor is .92 lagging. The line voltage is _____ V. The line current is _____ A. The apparent power consumed by the motor is _____ KVA. The power consumed by the motor is _____ W.

24. (20) Partial nameplate data for an induction motor is as follows: HP 180, VOLTS 460, PH 3, HZ 60, RPM 1777, POWER FACTOR 85.5, TIME RATING CONT, AMP 210, SERVICE FACTOR 1.15. Find a) the electrical input power to the motor under full load (in kW), and b) the efficiency of the motor. c) What would you expect for the no-load speed of this motor?

25. (21) More Quickies

- a) _____ error in a sensor system is most likely caused by magnetism or friction.
- b) The Thevenin resistance of a circuit is equal to the open circuit voltage divided by the _____.
- c) A 15 μF capacitor has a voltage of 8 V. The charge on the capacitor is _____ μC .
- d) A (an) _____ capacitor will have a + sign on one of its terminals. If you connect it backwards, it may explode.
- e) Microprocessors are used for general computing. _____ are used in special purpose embedded applications.
- f) If the input to an amplifier is a pure sinusoid of 50 Hz, and the output of the amplifier contains frequencies of 50 Hz, 100 Hz, 150 Hz, and 200 Hz, the amplifier probably suffers from _____ distortion.
- g) An op-amp used as a differential amplifier should have a high common mode _____ ratio.

Bonus (+5) In most BJT data sheets, you will see _____ instead of β as the DC current gain of the transistor.

Bonus (+5) An inverting op-amp circuit has an R_S of 33 $\text{k}\Omega$ and an R_F of 68 $\text{k}\Omega$. In order to compensate for bias currents, the resistor connected between the + input and ground should have a value of _____ $\text{k}\Omega$.