

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

1. (176) Quickies

- a) A certain amplifier has a voltage gain of 15,000. Its gain in dB is _____. If its input voltage is 45 μV , its output is _____ V.
- b) A (an) _____ is frequently inserted between two amplifier stages to block DC offset voltages.
- c) Industrial customers of electric utilities pay a “demand charge” based on the maximum _____ used in the billing cycle.
- d) What type of battery is typically used in a laptop computer? _____
- e) An A/D converter collects 10,000 samples of the analog input every second. What is the highest frequency that can be present in the analog input without causing aliasing? _____ Hz
- f) A (an) _____ voltage regulator is power-efficient and may have several different voltage outputs.
- g) What type of memory is commonly used in a USB drive (thumb drive)? _____
- h) Ventricular _____ can be caused by current flowing through the heart.
- i) What is the most common device used for power factor correction? _____
- j) The current through a (an) _____ cannot be changed instantaneously.
- k) How much charge flows through a 20 Ω resistor carrying 10 mA for 2 minutes? _____ C
- l) Coax cable, such as used with cable TV, should be connected only to devices that have an input impedance of _____ Ω .
- m) A “200 Ω resistor” has a tolerance of 10%. It could have a resistance as low as _____ Ω .
- n) The transformer, choke, and solenoid are all based on what basic passive component? _____
- o) At a certain instant in time, a 20 μF capacitor has a voltage of 12 V and a current of 7 A. The charge on the capacitor at this time is _____ μC .
- p) Circuits that are driven by low-voltage signal sources, such as sensors, should be grounded in only one place to prevent noise caused by ground _____.

q) What is the numerical value of the gain of any simple RC filter at the cutoff frequency? _____

r) Of the capacitor, inductor, and resistor, which device is *least* ideal? _____

s) Convert $0101\ 0110_2$ to decimal: _____

t) A sensor with a low voltage is to be connected to a differential amplifier. Which of the following cabling choices is *not* appropriate for connecting the sensor to the amplifier? coax, twisted shielded pair, twisted pair, shielded cable

u) _____ instead of microprocessors are usually used in embedded applications.

v) Sketch and label a D flip-flop.

w) An amplifier has its 3 dB points at 80 Hz and 5,000 Hz. Its bandwidth is _____ Hz.

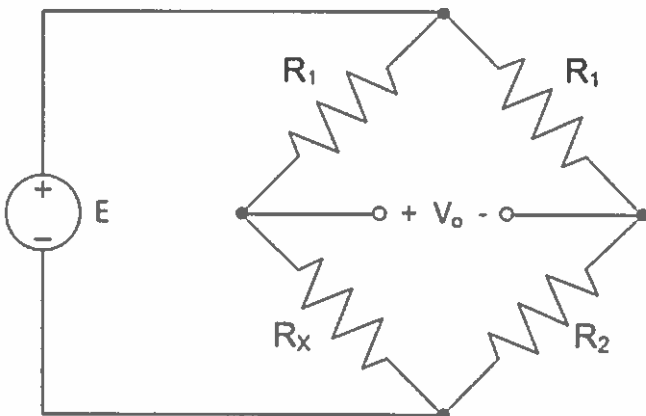
x) The two _____ inputs of the 741 op-amp are used for fine tuning to adjust the output voltage to zero when the input voltage is zero.

y) Of the secondary (storage) batteries we have studied, which has the highest energy density?

z) A fresh AA alkaline battery will have a terminal voltage of approximately _____ V.

aa) Of incandescent, CFL, and LED light bulbs, _____ costs the least to buy, and _____ has the highest efficiency.

bb) What is the circuit below called?



- cc) Hysteresis error in measurement is usually caused by either _____ or friction.
- dd) CMRR (common mode rejection ratio) is an important feature of _____ amplifiers.
- ee) Name the memory technology that needs refresh. _____
- ff) What kind of motor has a torque-speed curve that is just a vertical line? _____
- gg) What kind of three-phase motor rotor has no wire? _____
- hh) A certain device uses 39,000 J. How much is that in kWh? _____ kWh
- ii) A “black box” has two wires sticking out of it. The black box is known to contain only resistors and DC sources. When a voltmeter is connected between the 2 wires, the voltmeter reads 20 V. When the voltmeter is replaced with an ammeter, the ammeter reads 4 A. The Thevenin equivalent circuit for the black box will be a _____ V DC source in series with a _____ Ω resistor.
- jj) A circuit is powered by a 60 V battery and 13 A current source. There is a 10 Ω resistor in the circuit. If the 13 A current source is open-circuited, the current in the resistor is 7 A downward. If the 60 V voltage source is short-circuited instead, the current in the resistor is 3 A upward. If both the sources are active, the downward current in the resistor will be _____ A.
- kk) The material between capacitor plates is called the _____.
- ll) A (an) _____ three-phase system will have all the currents in all the lines equal in magnitude.
- mm) Three-phase motors are usually connected in which configuration? (delta, star, wye)
- nn) A high pass filter has a cutoff frequency of 100 Hz when nothing is connected to the output. If a resistor is connected to the output, the cutoff frequency will (decrease, increase, remain the same).
- oo) In order to avoid the “memory bottleneck,” _____ is frequently inserted between the processor and main memory.
- pp) A certain single-core microprocessor can fetch an instruction while at the same time decoding another instruction and executing a third instruction. This process is called _____.
- qq) Lowering the operating voltage of a microprocessor can reduce the effects of quantum _____.
- rr) One advantage of the solid-state relay over the mechanical relay is that the solid-state relay has no _____ kickback.
- ss) List the three highest synchronous speeds possible in a 60 Hz system.
 _____ rpm _____ rpm _____ rpm

tt) A load cell (strain gauge) changes its _____ as the device is deformed.

uu) Overhead three-phase lines have a line-to-line voltage of 12,470 V. The line-to-neutral (or line-to-ground) voltage is _____ V.

vv) Two amplifiers are connected in series, so that the output of the first amplifier feeds the input of the second amplifier. The first amplifier has a gain of 18 dB. The second has a gain of 22 dB. The total gain of the two amplifiers is _____ dB.

ww) A (an) _____-wave rectifier uses both the positive and negative halves of an input sinusoid to produce a DC voltage.

xx) It is usually desirable for a voltage amplifier to have a high _____ impedance.

yy) It is usually not a good idea to connect batteries in parallel, because good batteries can discharge through _____ batteries.

zz) To correct for _____ errors in measurement systems, take many measurements and average the results.

aaa) The main memory of a desktop PC is usually (DRAM, Eidetic, Flash, ROM, SRAM)

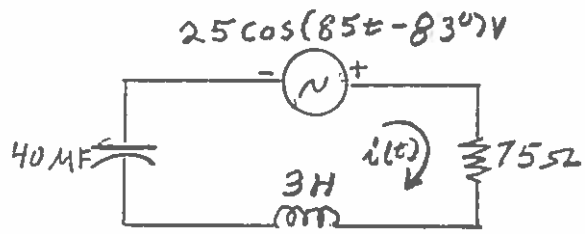
bbb) What device is required for electrical installations in outdoor and wet locations that can protect people from current paths to ground?

2. (25) You have a 0.5 μF and an assortment of resistors. a) Specify an appropriate resistor for a high-pass filter with a cut-off frequency of 20 kHz. b) Sketch and label the filter. c) What is the gain of the filter at a frequency of 4 kHz?

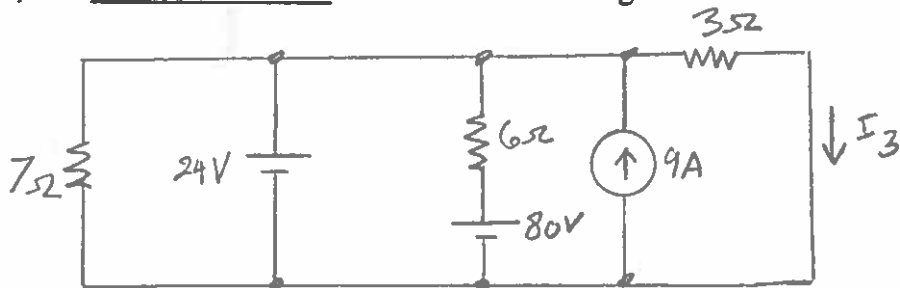
3. (20) A three-phase delta-connected induction motor uses 85 kVA at 88% PF lagging when connected to a 230 V three-phase line. a) Sketch and label the circuit. Find b) the line current, c) the phase voltage, and d) the phase current.

4. (25) A milling machine consumes 11 kW at a power factor of 73% lagging from a 120 V 60 Hz line. A synchronous motor connected to the same line consumes 20 kVA at a power factor of 95% leading. a) Draw and label a power triangle for the milling machine. b) Draw and label a power triangle for the synchronous motor. c) Draw and label a power triangle for the combined load. e) What is the current in the line feeding the two machines?

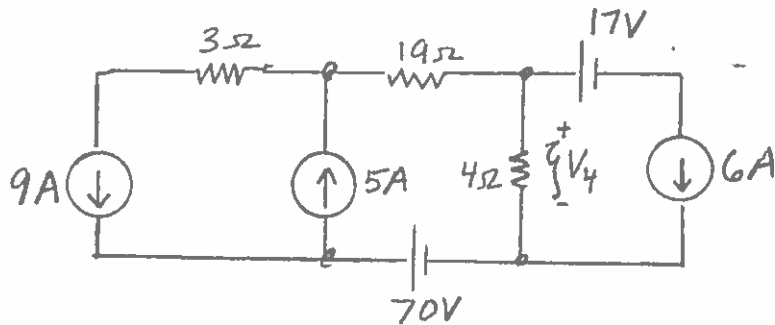
5. (25) Find the steady state value of $i(t)$. Use phasors.



6. (10) $I_3 =$ _____. The answer is an integer.

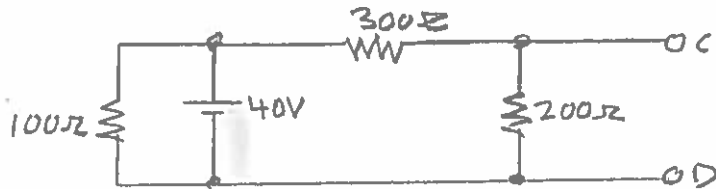


7. (10) $V_4 =$ _____. The answer is an integer.

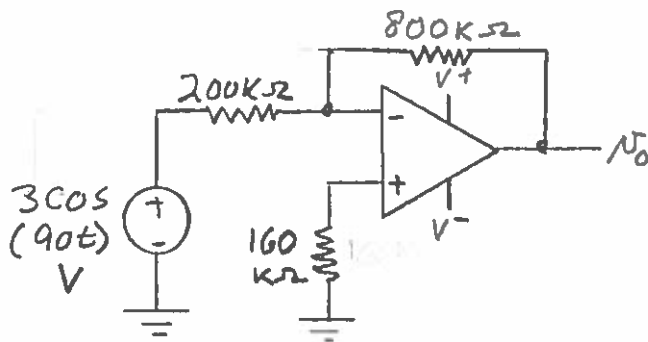


8. (10) Sketch and label a circuit that uses four three-state buffers to create a bus.

9. (25) a) Find and sketch the Thevenin equivalent circuit between C and D. The values of the components will be integers. b) What value of resistor connected between C and D will consume the most power?



10. (35) Assume the op-amp is ideal. a) Label the circuit. b) Carefully show your analysis to find v_o as a function of time using the assumptions for an ideal op-amp. c) Select appropriate values for V^+ and V^- .



11. (17) $i(t) = 50 \cos(30t + 12^\circ) \text{ A}$

$\omega =$ _____

$f =$ _____

$T =$ _____ s

$I_{avg} =$ _____ A

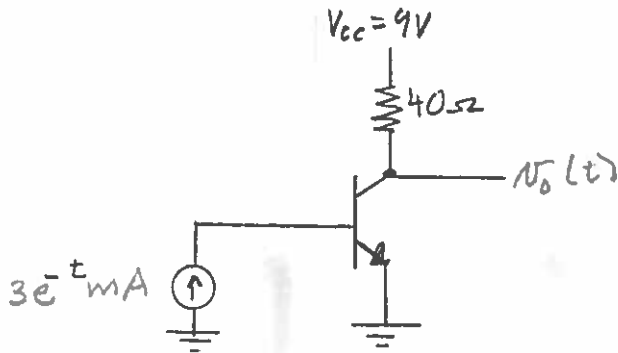
$I_{max} =$ _____ A

$I_{rms} =$ _____ A

$i(.01) =$ _____ A

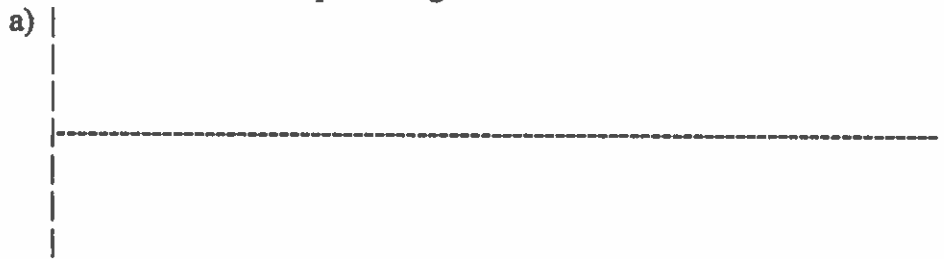
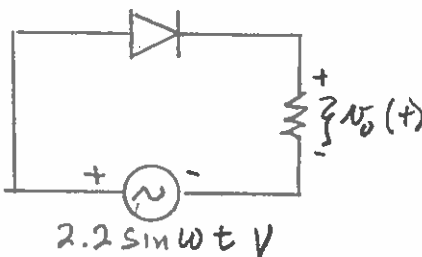
12. (5) In problem 11, the average power consumed by a 4Ω resistor carrying this current will be _____ W.

13. (12) The BJT shown below has the following information on its data sheet: $BV_{CBO} 55 \text{ V}$, $I_{CBO} .01 \text{ mA}$, $h_{FE} (\beta) 45$, $V_{BE} (\text{sat}) 2 \text{ V}$. Find $v_o(t)$.



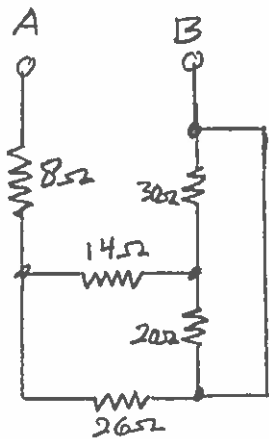
14. (20) The nameplate on a transformer reads: PRI 120V, SEC 240V, VA 50. The primary of the transformer is connected to a 120 V AC source, and the secondary is connected to a load that draws 0.3 A. a) Sketch and label the transformer circuit. b) What is the current in the primary? c) Is the transformer operating within its safe range? Justify your answer. d) If the primary is connected to a 6 V battery instead of the 120 V AC source, what is the secondary voltage?

15. (10) Assume the diode is ideal. a) Carefully sketch $v_o(t)$ in the space provided, giving numerical values for voltage. b) What simple device can be used to smooth the output voltage?

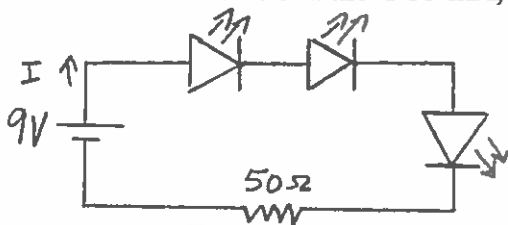


b) _____

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



17. (15) The datasheet for the LED_s shown says: PRV 7.5 V, PEAK FORWARD CURRENT 105 mA, AVERAGE FORWARD CURRENT 35 mA, FORWARD VOLTAGE 2.5 V. Find the current.



18. (21) From the following list of motors, identify which motor best fits each application below: Three-phase synchronous motor, three-phase induction motor, single-phase synchronous motor, single-phase induction motor, DC parallel (shunt)-connected motor, series (universal) motor, permanent magnet DC motor, stepper motor, brushless DC motor, variable-reluctance motor. It may be necessary to enter a motor type more than once, or not at all.

Residential air conditioner compressor motor: _____

Inkjet printer head positioning motor: _____

Very high power, low speed industrial motor: _____

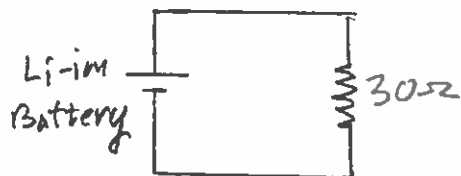
Motor for an electric clock: _____

50 HP industrial motor to drive a pump: _____

Industrial motor with an electromagnet as the rotor: _____

Industrial motor with a squirrel cage rotor: _____

19. (10) The Li-ion battery shown has the following specifications: Nominal Voltage 3.7 V, Typical Capacity 2200 mAh, Charging Current 0.5 C₅A, Internal Impedance < 70 mΩ. How long will the battery last before it needs to be recharged.



20. (10) An 8-bit A/D converter has $V_{ref+} = 3 \text{ V}$ and $V_{ref-} = -1 \text{ V}$. The analog voltage is 0.7 V . The binary output of the A/D converter is _____.

21. (13) Sketch a parallel resonant circuit consisting of a $100 \text{ k}\Omega$ resistor, a $2.5 \mu\text{F}$ capacitor, and a 15 mH inductor. The resonant frequency of the circuit is _____ Hz. The impedance of the circuit at resonance is _____ Ω .

22. (15) Give the colors of these wires found in residential wiring.

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

23. (21) The nameplate data for an induction motor is as follows: HP 250, VOLTS 460, PH 3, HZ 60, RPM 1773, POWER FACTOR 89.4, TIME RATING CONT, AMP 290, SERVICE FACTOR 1.15. Find a) the electrical input power to the motor under full load, and b) the efficiency of the motor. c) What would you expect for the no-load speed of this motor?

24. (+5 Bonus) Power PC and ARM, but not Pentium, are _____ microprocessor chips.