ECE 252 **Introduction to Electrical Engineering** **Final-16S-2**
515 Points **Show your work.** **Name**_____
Fill in the blanks, circle the correct answers, etc.

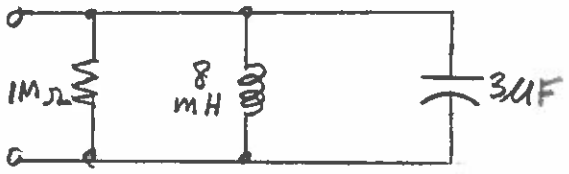
1. (194) Quickies

a) Sketch and label an NPN BJT.

b) A NiCd 1.2 V battery draws 55 mA in a hobby application. It's supposed to last for 40 hours of continuous operation before it needs to be recharged. The minimum capacity the battery should have is _____ mAh.

c) A certain motor is rated at 60 hp. Its torque is 500 Nm. The shaft speed is _____rpm.

d) The circuit below is a (compound, parallel, series) resonant circuit. Its resonant frequency is _____ Hz. Its impedance at the resonant frequency is _____ Ω. At any other frequency, the impedance will be (less than, more than, the same as) the impedance at resonance.



e) An 1100 W hairdryer, operated from 120V commercial power has been left on for 40 minutes. It has used _____ J of energy, or _____kWh.

f) The voltage across a (an) _____ cannot be changed instantaneously.

g) The three possible outputs of a three-state device are logic 0, logic 1, and _____.

h) Electric utilities usually impose a demand charge on industrial customers based on the maximum _____ the customer uses in a billing cycle.

i) When selecting an op-amp to use as a differential amplifier in a noise-prone application, pick an op-amp with a high _____.

j) What memory technology will be most likely used as the main memory of a desktop PC?
_____

k) What memory technology will be most likely found inside a microprocessor chip?

_____

l) What type of electrical receptacle should be installed in wet and outdoor locations?

_____

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

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

n) The energy of an inductor is stored in the _____ field.

o) A 20 mH inductor carries a current of $3 + 10e^{-15t}$ mA. Its voltage is _____ mV.

p) What simple device is used to smooth voltages, reduce hum, and link amplifier stages?

_____

q) CISC microprocessor architecture is associated with many complex instructions of varying length that execute in varying amounts of time. _____ microprocessor architecture is associated with few instructions, all of the same length, and all running in the same amount of time.

r) What is the numerical value of the gain of a filter at the "3 dB point?" _____

s) A low-pass filter has a calculated cut-off frequency of 200 Hz when nothing is connected to it. If the filter is driven by a circuit with a Thevenin equivalent resistance of 100 Ω, the cut-off frequency will (increase, decrease, remain the same).

t) $1010\ 1110_2$ = _____ in decimal (base 10)

u) DRAM requires _____ periodically, or it will lose its data.

v) A solid state drive (SSD) for a computer uses what memory technology? _____

w) Embedded devices usually use _____ rather than microprocessors.

x) Coprocessors were added to microprocessor chips mostly to handle _____ point operations.

y) When a modern microprocessor needs data or program instructions, it first looks in _____ memory, before looking at the computer's main memory.

z) One formulation of _____ Law predicts that computing power doubles periodically over time.

aa) A D-type flip-flop has a logic 1 on its D input. A pulse arrives at the clock (trigger) input. A short time later, _____ appears on the Q output and _____ appears on the Q' output.

bb) In the space below, sketch the wave shape of the output of a half-wave rectifier.

cc) An amplifier has a lower 3dB point of 50 Hz and a bandwidth of 800 Hz. Its upper 3 dB point will be at _____ Hz.

dd) The input to an amplifier is a 100 Hz pure sinusoid. The output contains the following frequencies: 100 Hz, 200 Hz, 300 Hz, and 400 Hz. This amplifier suffers from _____ distortion.

ee) Capacitors are frequently used between amplifier stages to block _____ voltages.

ff) _____ cable has a characteristic impedance of 75 Ω.

gg) A (an) _____ relay is faster, smaller, less noisy, and lasts longer than an equivalent mechanical relay.

hh) The gain of many op-amps frequently (decreases, increases, remains the same) as frequency increases.

ii) Enter the nominal voltages for one cell of each of these batteries:

Sealed lead acid (SLA) _____
Nickel-metal hydride (NiMH) _____
Zinc-alkaline (alkaline) _____
Lithium ion (Li-ion) _____

jj) You should recharge your cell phone when the available capacity drops to (10%, 40%, 60%, 90%)

kk) For light bulbs, CFL stands for _____ _____ _____.

ll) The LM 7805 is a _____ voltage regulator.

mm) Sketch a photodiode.

nn) A certain pressure sensor has a measured output that is too low when the temperature is increasing and too high when the temperature is decreasing. This sensor suffers from a (an) _____ error.

oo) A (an) _____ is a sensor that decreases its resistance as the temperature increases.

pp) Coax cable can be connected between a sensor and a (an) _____-ended amplifier to reduce noise.

qq) To avoid noise due to ground loops, ground a system in _____ place.

rr) For AC induction motors, the armature windings are on the (commutator, field coils, rotor, stator).

ss) Approximately 80% of all AC motors are _____ motors.

tt) Electrical losses in AC motors are copper losses (i^2R), hysteresis, and _____ currents.

uu) Back _____ is proportional to motor speed and field strength.

vv) Sketch and label the torque-speed for a series (universal) motor.

ww) _____ fibrillation is erratic contraction of the heart muscle, sometimes caused by accidental electrocution.

xx) The distribution transformer that provides 240V/120V to residences is a (an) _____-tapped transformer.

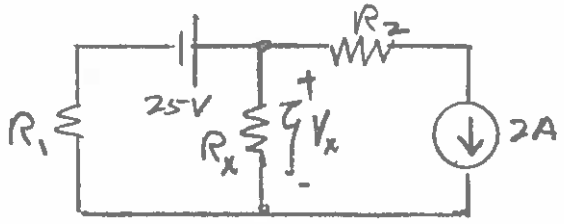
yy) The watt-hour meter on your residence measures (current, energy, power, voltage).

zz) If you must work on a circuit that you think is "hot," what should you keep in your pocket?

_____

2. (25) A milling machine consumes 12 kW at a power factor of 0.75 lagging from a 120 V 60 Hz line. A 5 KVAR capacitor is connected to the same line. Draw power triangles for each of the devices and another power triangle for the total load. What is the current in the line feeding the two devices?

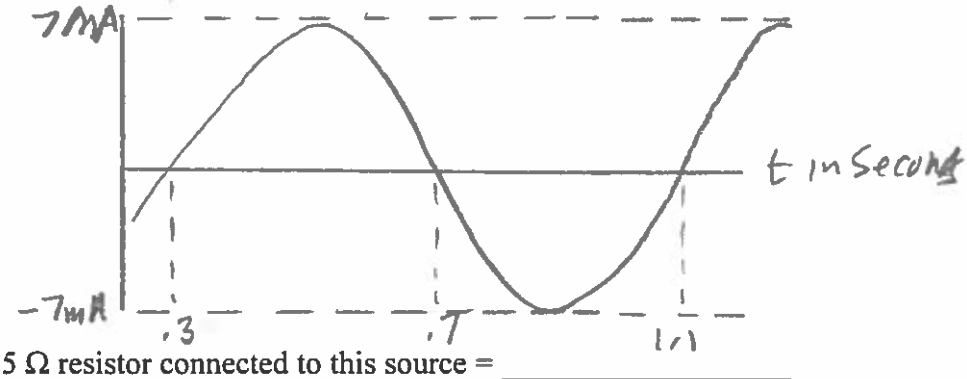
3. (10) When the 2 A source is open circuited, $V_x = 19$ V. When the 25 V source is short circuited, $V_x = -11$ V. What will V_x be if both sources are active?



What do you call the "principle" used to solve this problem? _____

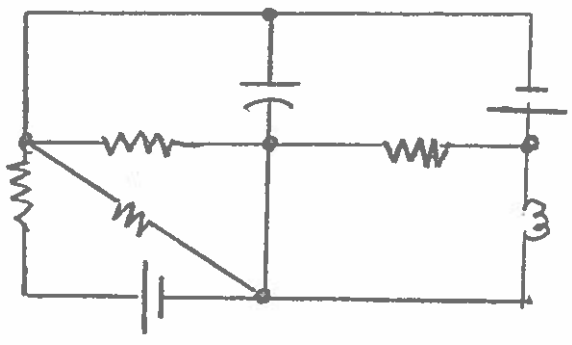
4. (25)

I_{max} = _____
I_{avg} = _____
I_{rms} = _____
T = _____
f = _____
ω = _____
i(t) = _____
Phasor **I** = _____

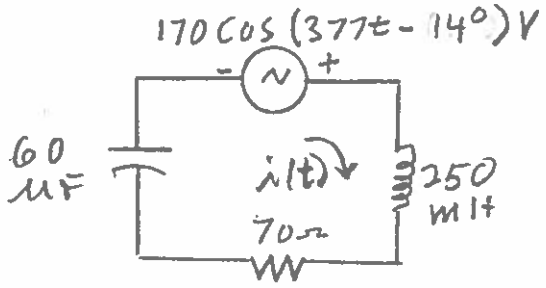


Average power consumed in a 25 Ω resistor connected to this source = _____

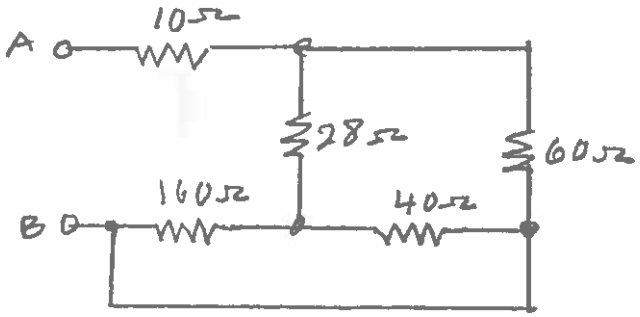
5. (15) Circle the essential nodes in this circuit. There are _____ KCL equations required for this circuit. There are _____ KVL equations required.



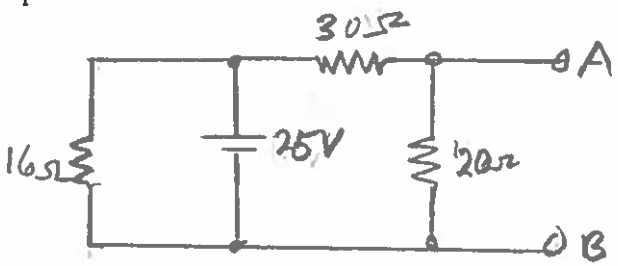
6. (25) Sketch and label appropriate circuits. Find the steady state value of i(t). Use phasors.

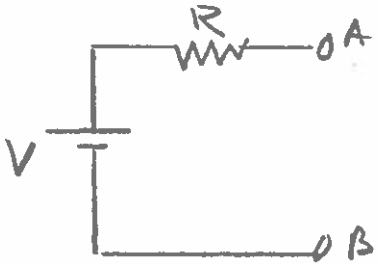


7. (10) R_{AB} = _____. The answer is an integer.

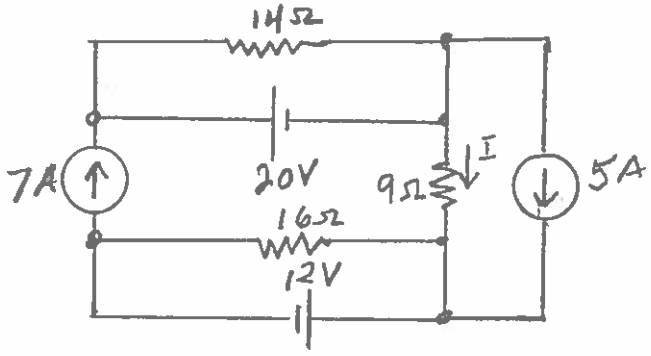


8. (15) The network at the left is to be replaced with the equivalent network at the right. a) Find V and R. b) What resistor can be connected between A and B to have that resistor consume the most possible power?

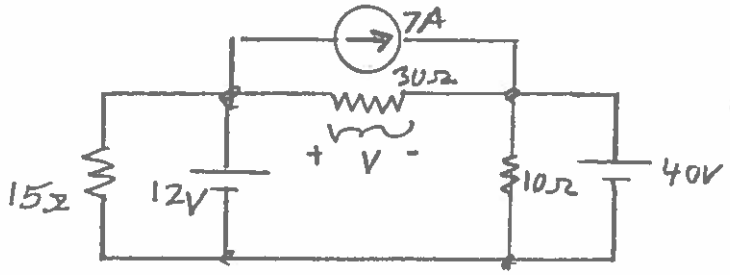




9. (10) I = _____ (It's an integer.)



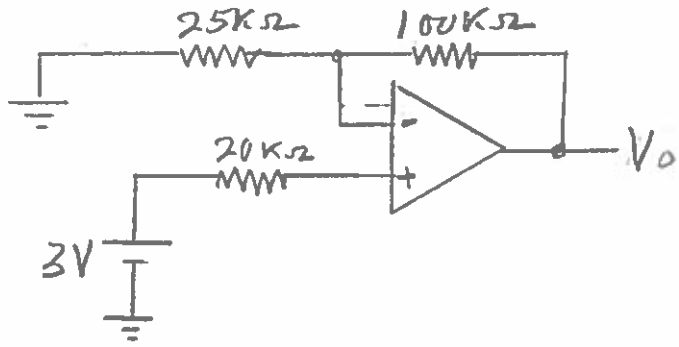
10. (10) V = _____(It's an integer.)



11. (15) An 8-bit A/D converter has $V_{ref-} = 0$ V and $V_{ref+} = 5$V. The input analog voltage is 2 V. The binary output is _____. If the analog input contains frequencies from 100 Hz to 900 Hz, the sampling rate of the A/D converter must be at least _____samples/second.

12. (20) A three-phase delta-connected motor has a phase voltage of 230 V and a phase current of 55 A. Its power factor is .87 lagging. a) Sketch the circuit. b) The line voltage is _____V. c) The line current is _____A. d) The apparent power consumed by the motor is _____KVA. e) The power consumed by the motor is _____kW. f) The power consumed in one phase of the motor is _____ kW.

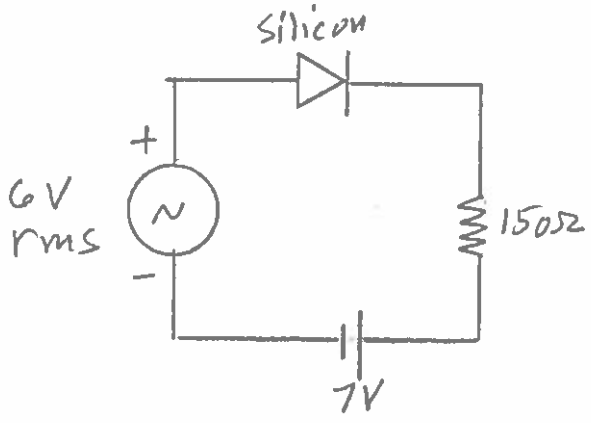
13. (25) The op-amp is ideal. a) Label the diagram. b) Find V_o. Carefully show your analysis using the assumptions for an ideal op-amp. c) specify appropriate power supplies for the op-amp.



14. (21) 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.

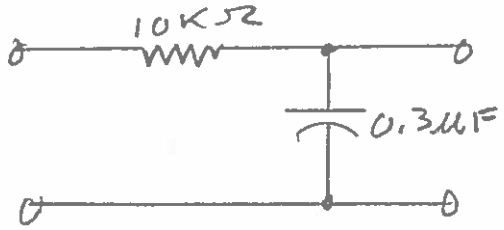
Small hobby motor operated by batteries: _____
10,000 hp industrial motor with a large constant load: _____
Industrial motor with simple, rugged construction: _____
Hand-held electric drill: _____
Print head motor for ink jet printer: _____
Industrial 3600 rpm motor with precise speed: _____
Dishwasher motor with a squirrel cage rotor: _____

15. (10) The diode is made of silicon. Find the maximum forward current.

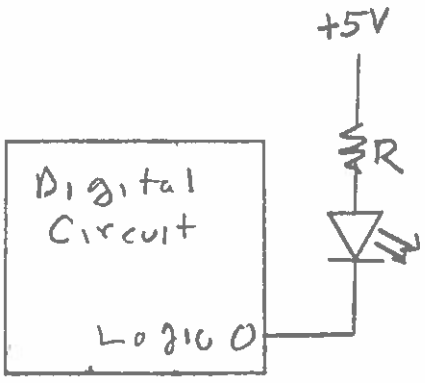


16. (20) Transformer nameplate data is as follows: "Pri. 120 V, 60 Hz, Sec. 24 V, 8 VA." This transformer is plugged into the wall and the output terminals are connected to a load that draws 100 mA. a) Sketch and label the circuit. b) What is the current in the primary? c) If the transformer were connected to a 120 V battery, instead of being plugged in, what would the secondary current be?

17. (20) The filter below is a (band pass, high pass, low pass, notch) filter. At a frequency of 150 Hz its gain in dB is _____.

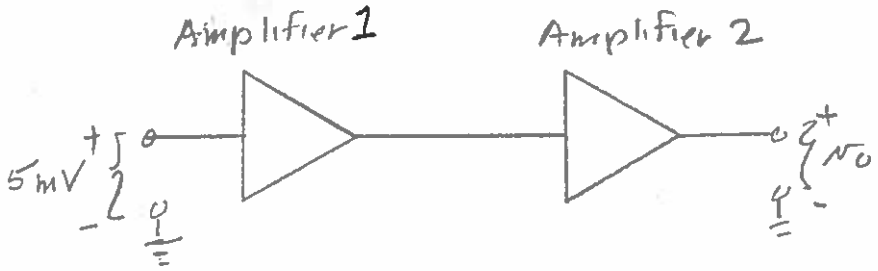


18. (10) Below is a typical circuit for lighting an LED from the logic 0 of a digital output. If the diode has a forward voltage drop of 1.8 V and has a maximum average current of 20 mA, calculate the value of the resistor to get the maximum brightness.



19. (20) The nameplate data for an induction motor is as follows: HP 325, VOLTS 460, PH 3, HZ 60, RPM 1180, POWER FACTOR 86.7, TIME RATING CONT, AMP 390, SERVICE FACTOR 1.12. 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?

20. (15) Two amplifiers are shown below. Amplifier 1 has a gain of 18 dB. Amplifier 2 has a gain of of 25 dB. a) Find the total gain of the system in dB. b) Find v_o.



BONUS (+5) Copper is the metal of choice for low-voltage wiring. What metal is most often used for high-voltage (4000+ volts) wiring? _____