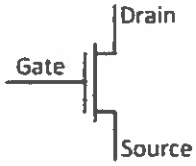
ECE 252 **Introduction to Electrical Engineering** **Final-18S-1**
516 Points **Show your work.** **Name**_____
Fill in the blanks, circle the correct answers, etc.

1. (184) Quickies.
a) A three-state buffer has a logic 0 input. The gate is off. What is the output? _____

b) An 8-bit A/D converter has $V_{ref+} = 3$ V and $V_{ref-} = 1$ V. If the analog input is 3.3 V, the binary output is _____.

c) What is this device called? _____



d) A weight scale consistently reads 1.5 lbs low. This is an example of a(n) _____ error.

e) 00100111 in binary is _____ in decimal.

f) Which one of the following cable types should *not* be connected between a sensor and a differential amplifier? Shielded cable, twisted pair, shielded twisted pair, coax.

g) The data in DRAM must be read periodically and written back to prevent the decay of the data. This process is called _____.

h) If a relay or solenoid in a DC circuit suffers from "inductive kickback," put a(n) _____ across the coil.

i) The voltage across a(n) (capacitor, inductor, resistor, transistor) cannot be changed instantaneously.

j) A certain device stores 180,000 J of energy. How much is that in kWhs? _____

k) If there are 17 essential nodes in a network, you need _____ KCL equations.

l) A circuit with 11 meshes requires _____ KVL equations.

m) List the colors of these three wires that are used in residential wiring:
120v ("hot"): _____
Return (neutral): _____
Ground: _____

n) 5 A flows through a resistor for 2 minutes. The total charge that went through the resistor is _____ C.

o) A resistor with a gold band has _____ % tolerance.

p) Which of these devices is the *least* ideal? (capacitor, inductor, resistor)

q) The material between the plates of a capacitor is called the _____.

r) Residential electric utility customers are likely to pay a base charge and a(n) _____ charge.

s) In what season of the year is electrical energy use the highest? (winter, spring, summer, fall)

t) Typical three-phase line-to-line voltage at utility poles is 12,470 V. The line-to-ground (line-to-neutral) voltage is _____ V.

u) In a three-phase system, if all three phases have the same voltage and the same current, we say that we have a(n) _____ three-phase system.

v) The cutoff frequency or 3 dB point is also called the half-_____ point.

w) RAM is _____. This means it loses its data when the power is removed.

x) How many transistors are used to make one DRAM memory cell? _____

y) The most common form of EEPROM today is _____. It's used in USB drives and SSDs.

z) An A-to-D converter has an input signal that contains frequencies from 40 Hz to 800 Hz. The A-to-D converter should have a sampling rate of at least _____ samples per second to prevent aliasing.

aa) Unlike general purpose microprocessors, _____ are embedded to perform a specific task.

bb) Moore's Law states that microprocessor capability will approximately _____ every 18 months.

cc) Most mobile phones use (CISC, DISC, FISC, MISC, RISC, SISC) processors.

dd) _____ is fast memory between the processor and the main memory. It is used to reduce the effect of the "memory wall."

ee) Sketch and label a D-type flip-flop.

ff) An NPN BJT has an h_{FE} of 75 and an I_{CEX} of 10 nA. If I_B = 5 mA, I_C = _____ mA.

gg) A good audio amplifier will have a (low, moderate, high) input impedance and a (low, moderate, high) output impedance.

hh) _____ are frequently used between amplifier stages to eliminate DC voltage offset.

ii) A secondary battery with a capacity of 2500 mAh is used in a circuit that draws 12.5 mA. The battery must be recharged after _____ hours of operation.

jj) It's usually a bad idea to connect batteries in _____ to get extra current.

kk) List the nominal voltages of these batteries:
Lithium ion (rechargeable): _____
Zinc-alkaline: _____
NiMH: _____
SLA: _____

ll) Of the three types of light bulbs we studied, which one cannot be dimmed? _____

mm) The LM 7805 voltage regulator has a stable DC output voltage of _____ V.

nn) This device is called a(n) _____.

oo) Back _____ in motors is proportional to field strength and shaft speed.

pp) Ventricular _____ can occur if current flows through the heart.

qq) What part of your body is your "first line of defense" against electric shock? _____

rr) A ground fault circuit interrupter (GFCI) will trip (switch off) when it detects a current between the hot side of the supply and _____.

ss) The output of an op-amp has a minimum value of -11.5 V and +3.7 V. Select appropriate power supplies for the op-amp. V^+ = _____ V. V^- = _____ V.

tt) The current in a 5 H inductor is $3 + 4e^{-5t}$ A. Its voltage is _____ V.

uu) _____ has a high magnetic permeability. That's why it is used as the core for motors.

vv) p(t) is constant in _____ three-phase systems.

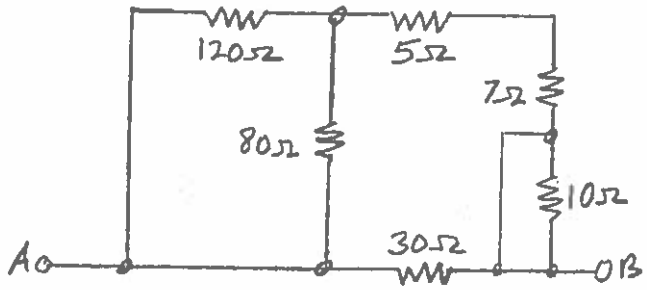
ww) Two amplifiers are connected in series. Each has a gain of 7. The input voltage to the first amplifier is 3 mV. The output voltage of the second amplifier is _____ mV.

xx) An amplifier has its upper cutoff frequency at 1000 Hz and its lower cutoff frequency at 100 Hz. The bandwidth of the amplifier is _____ Hz.

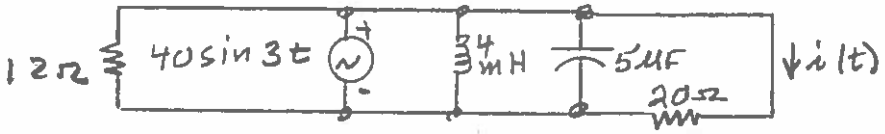
yy) Coaxial cable, as used in cable TV, has a _____ impedance of 75 Ω.

zz) If a sensor has a low output voltage in an environment with electronic noise, it's probably better to use a(n) _____ amplifier than a single-ended amplifier.

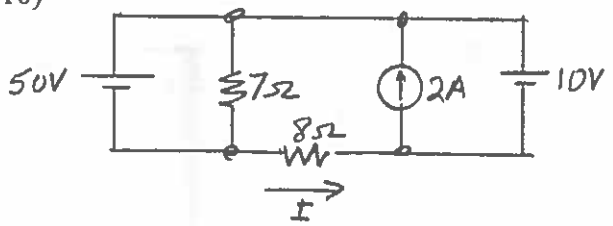
2. (20) Find the resistance between A and B. The answer is an integer.



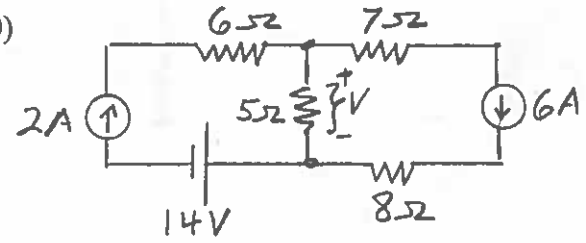
3. (10) i(t) = _____



4. (10) I = _____



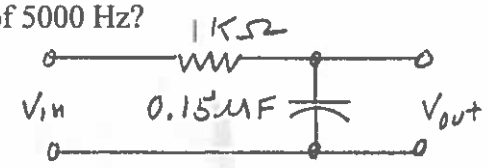
5. (10) V = _____



6. (20) A "black box" with 2 leads sticking out of it is known to contain only DC sources and resistors. The short circuit current is found to be 6A. The current through a 10 Ω resistor is found to be 4A. Sketch and label the Thevenin equivalent circuit for the "black box".

7. (20) A 3-phase Y-connected generator is connected to a balanced delta-connected load. Each phase of the generator has a voltage of 277 V. The load consumes 25 kW at 69% PF lagging. Find a) the line voltage, b) the phase voltage of the load, c) the line current, and d) the phase current of the load.

8. (20) Find the cutoff frequency of this filter. What is the gain of the filter in dB at a frequency of 5000 Hz?



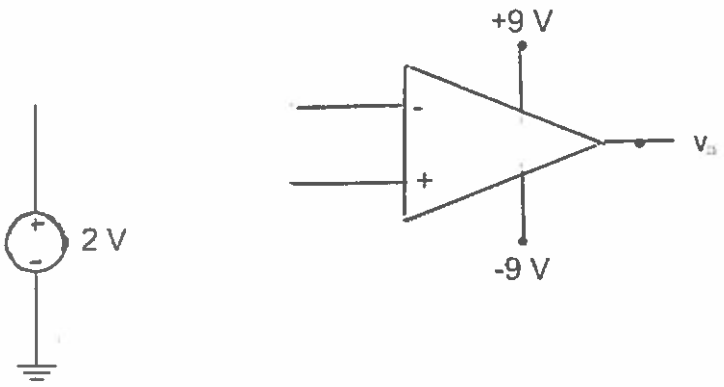
9. (35) $i(t) = 100 \cos(40t - 20°)$A

Imax = _____
Imin = _____
Iavg = _____
Ipeak to peak = _____
Irms = _____
T = _____
ω = _____
f = _____
Phasor I = _____
i(.02) = _____

If this current were to flow through a 5Ω resistor, the average power consumed would be_____ W.

10. (8) A series-resonant circuit consists of a 20 kΩ resistor, a 15 mH inductor, and a 5 μF capacitor. The resonant frequency is _____ Hz. At resonance, the impedance of the circuit is _____ Ω.

11. (25) The op amp shown is ideal. Add components so that v_0 is -6 V. Resistors available: 10 kΩ, 20 kΩ, 30 kΩ, 50 kΩ, 80 kΩ, 100 kΩ. Capacitors available: 1 μF, 5 μF, 10 μF. Carefully label and analyze the circuit to prove that it has the correct output.



12. (20) A motor connected to a 220 V AC single-phase line consumes 40 KVA with a power factor of 0.62 lagging. A 20 KVAR capacitor is also connected across the line. Find the current in the line feeding the two devices.

13. (15) Specify an appropriate battery type (SLA, Li-ion, NiCd, NiMH, alkaline, zinc-air) for each of the applications below.

Cellular phone: _____
Laptop computer: _____
Motorcycle: _____
D-cell flashlight: _____
Pen-sized laser pointer: _____

14. (36) For each of the applications or descriptions below, select the most appropriate motor type from the following list: Brushless DC, single-phase induction, three-phase induction, permanent magnet, series (universal), shunt, stepper, single-phase synchronous, three-phase synchronous, variable reluctance. It may be necessary to enter a motor type more than once, or not at all.

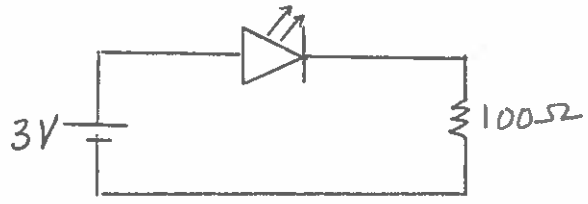
Hand-held kitchen mixer: _____
Industrial motor for driving a large fan: _____
Small, cheap toy car: _____
Industrial motor with a wireless squirrel cage rotor: _____
Automotive starter motor: _____
Most common industrial motor: _____
Capacitor-start motor: _____
Industrial constant-speed motor: _____
Industrial motor used for power factor correction: _____
DC motor with commutator and brushes: _____
Motor that rotates fixed amount with each pulse: _____
Motor with an electronic commutator: _____

15. (8) Sketch and label the speed-torque curve for an induction motor.

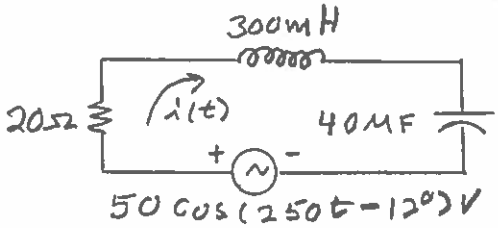
16. (15) Nameplate data on a transformer reads: "PRI 120 V, 60 HZ, SEC 252 V, 12 KVA." The primary is connected to a 120 V, 60 Hz source, and the secondary is connected to a resistance of 15 Ω. a) Sketch and label the circuit. b) What is the current in the primary?

17. (25) a) Sketch, and label the circuit for a half-wave rectifier circuit. Use an AC source with an rms voltage of 1.5 V, a silicon diode, and a 100 Ω load. b) Sketch and label the voltage across the load as a function of time, giving numeric values for appropriate voltages and clearly showing the shape of the voltage.

18. (5) The LED in the circuit below has a forward voltage drop of 2.3 V. How much current flows in the circuit?



19. (15) Find the steady-state value of i(t).



20. (15) The nameplate data for an induction motor is as follows: HP 180, VOLTS 460, PH 3, HZ 60, RPM 1780, POWER FACTOR 85.4, DUTY CONT, AMP 216, SERVICE FACTOR 1.25. Find a) the electrical input power to the motor under full load, b) the efficiency of the motor, c) the output angular velocity, and d) the torque. e) What would you expect for the approximate no-load speed of this motor?

a)

b)

c)

d)

e)

21. (BONUS +5) What company is currently the chief competitor of Intel in microprocessor manufacture? _____