Agricultural and Biosystems Engineering Dept.
Iowa State University

9/20/07
CJB

Name KEY

AE 363 - Exam 1

1 - 8 ½ x 11 sheet open (both sides)
Multiple Choice: 1 pt. each

1) In an AC circuit, power is used by
   a) resistances
   b) capacitances
   c) inductances
   d) all of the above
   e) (a) & (b)
   f) (a) & (c)
   g) (b) & (c)

2) When an extra series load is added to a series circuit,
   a) voltages across and currents through other loads are not changed.
   b) voltages change, but currents remain the same.
   c) currents change, but voltages remain the same.
   d) voltages across and currents through other loads change.

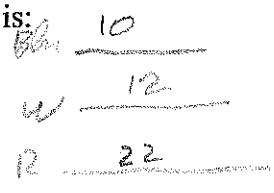
3) In an electrical circuit, electrons move
   a) from - to +
   b) from + to -
   c) alternately from - to + and then + to -
   d) depends on whether AC or DC circuit.

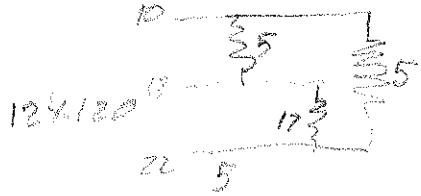
4) Cone heater resistances measured with the resistance meter were less than resistances computed using current and voltage readings because
   a) meters tend to read low on the resistance scale.
   b) DC resistance is less than AC resistance.
   c) of resistance of the conductors leading to the cone heater
   d) resistance of metal goes up as temperature increases.

5) Analysis of an electrical load shows a power factor of 1.1.
   a) this load has more inductive reactance than capacitive reactance.
   b) this load has more capacitive reactance than inductive reactance.
   c) resistance load on the circuit exceeds the sum of capacitive and inductive load.
   d) there has been an error in meters, meter reading, or calculations.

6) Negative instantaneous power in an AC circuit
   a) means energy stored in a reactive load component is flowing from the load to the generator.
   b) is impossible.
   c) means that resistive load components are adjusted to lower voltage by passing stored energy back to the generator.
   d) occurs only at power factors less than 0.5.

7) A 3-wire 120/240 volt branch circuit has only 120-volt resistive loads connected. Currents measured: Black: 10 amps White: 12 amps The wattage of the load connected between red and white is:
   a) 1440 watts
   b) 1200 watts
   c) 240 watts
   d) 2640 watts
   e) can't tell from information given





8) A GFI will NOT protect a person who contacts
   a) red conductor and earth
   b) black conductor and earth
   c) black conductor and neutral conductor

9) A 40-amp 240-volt load is turned on. How much does the current in the 7200-volt distribution line serving the farm go up?
   a) 1.33 amps
   b) 40 amps
   c) 0.75 amps
   d) cannot tell from information given

$240(40) = 7200(x)$
$x = 1.33$

10) Distribution line voltage is NOT 240 volts because
   a) traditionally it has been at least 7200 volts
   b) at 240 volts, the distribution line conductors would be too small to string between poles.
   c) line currents and hence line losses would be intolerably high.
   d) generator output is always over 240 volts

11) A 4kW load is connected through a watthour meter with Kh=7.2. How long does it take for the meter to register 1 kWh?
   a) 1 hour
   b) 1 min
   c) 28.8 min
   d) 1.8 min
   e) 15 min

$1\,kWh = 4kW(T_h)$
$T = .25h$

12) If a 240-volt load has no connection to neutral,
   a) the load will work, but not very well
   b) the load will not operate
   c) this violates code
   d) the load works normally

13) Voltage drop determines wire size for:
   a) very short distances
   b) very long distances
   c) heavy loads
   d) branch circuits
   e) aluminum conductors

14) The "on" position of a 3-way switch is
   a) up or down, depending on position of other switch
   b) up
   c) down
   d) up in U.S., down in Europe

15) A grounded circuit conductor is usually colored
   a) black
   b) white
   c) green or bare
   d) any color but white or green

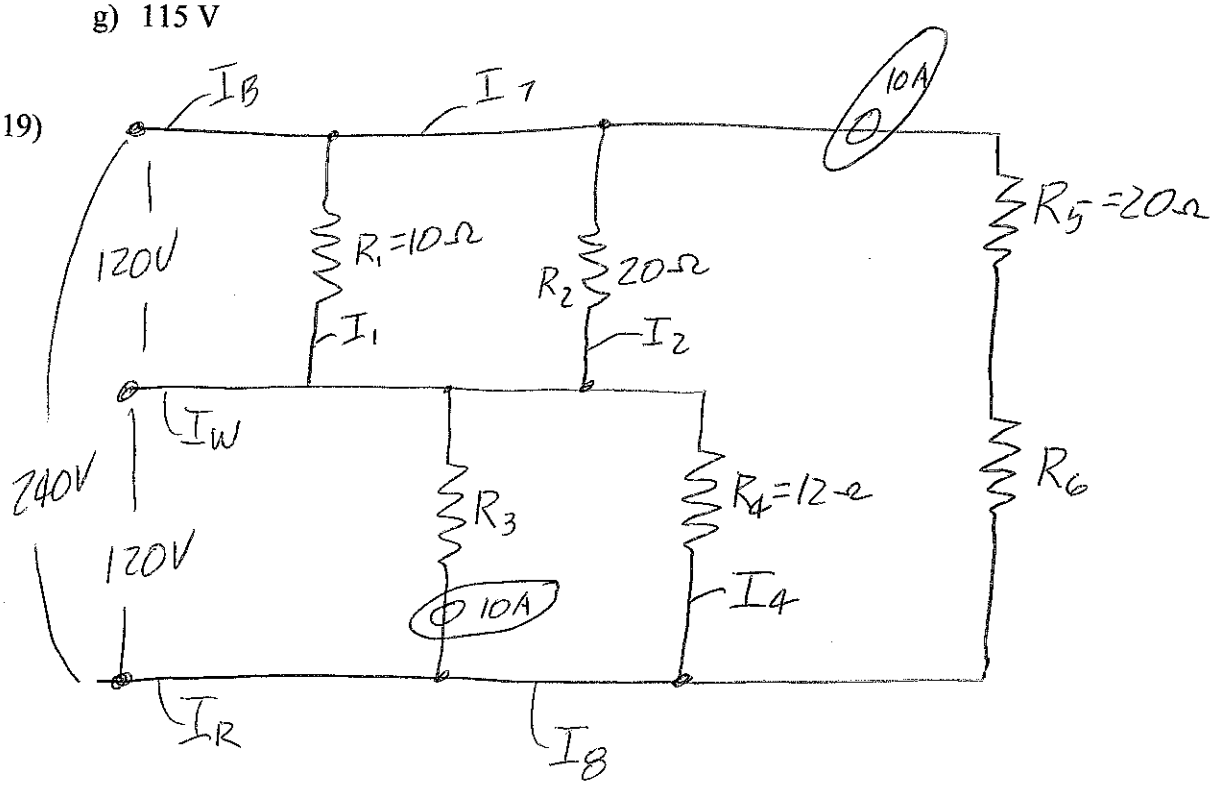
16) A copper conductor and an aluminum conductor have the same diameter.
   a) ampacity of each is the same
   b) ampacity of copper conductor is larger
   c) ampacity of aluminum conductor is larger
   d) we cannot decide on ampacity because length is not stated

17) A voltmeter placed in series with a load will:
   a) cause a short circuit, but no damage to the meter.
   b) read correctly the voltage across the load.
   c) shut off almost all current to the load.
   d) cause a short circuit and ruin the meter.

18) The maximum instantaneous voltage to ground occurring on a 120/240 v single phase system is about:

a) 240 V
b) 120 V
c) this depends on the type of meter used.
d) 170 V
e) 0 V
f) 84.6 V
g) 115 V

(20) 19)



Calculate:

	I1	12A	$I_1 = \frac{120}{10} = 12A$	Iwht	2
	I2	6A	$\frac{120}{20} = 6$	Ired	360
	R3	12Ω		Iblk	28A
(1.5)	I4	10A		(5) total power used	6960W
	R6	4Ω	$\frac{240}{20+R} = 10$		
	I7	16A	$240 = 200 + 10R$, $R = 4$		
	I8	20A			

$20 + 6 + 12 = 38 \times 120$
$+$
$240(10) = 6960W$

(21) 20. A 10-hp motor draws 50 amps when connected to a 240-V, 60-Hz power source. It operates at a power factor of 0.5.

$0.5 = \cos 60$

(a) Draw a phasor diagram referencing on voltage and another phasor diagram referencing on current. List the phase angle.

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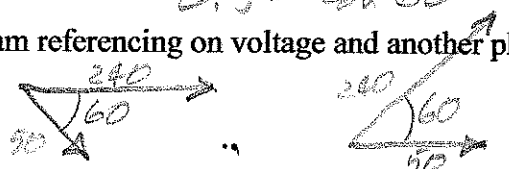

(b)Define components of a parallel R-L circuit which models this motor.

$R = \frac{240}{50\cos 60} = 9.6\,\Omega$ $\quad X_L = \frac{240}{50\sin 60} = 5.54\,\Omega$

5

(c) To improve the power factor of the entire facility, the owner wants to install a capacitor in parallel with this motor which will cause the motor-capacitor combination to operate at a power factor of 0.4 leading. Compute the value of the capacitor in microfarads.

$0.4 = \cos 66.4$

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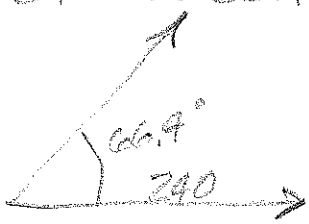


$I\cos 66.4 = 25$

$I = 62.44$

$I\sin 66.4 = 57.2 = I_C$

original $I_L = 50\sin 60 = 43.3$

$\frac{57.2}{43.3}$

$100.5 = I_C$

$X_C = \frac{240}{100.5} = 2.39\,\Omega$

$C = \frac{1}{2\pi(60)(2.39)} = 1110\,\mu F$

(d) Compute the current to the motor-capacitor combination in (c) and express in polar notation.

$I = 62.44\angle 66.4$

2

(e) Compute the impedance of the motor-capacitor combination in (d) and express in rectangular notation.

6

$\vec{Z} = \frac{\vec{E}}{\vec{I}} = \frac{240\angle 66.4}{62.44\angle 0} = 3.84\angle 66.4$

$= 1.53 - j3.52$

$P = (240)(\sin 66.4)(5) = 6000\,W$

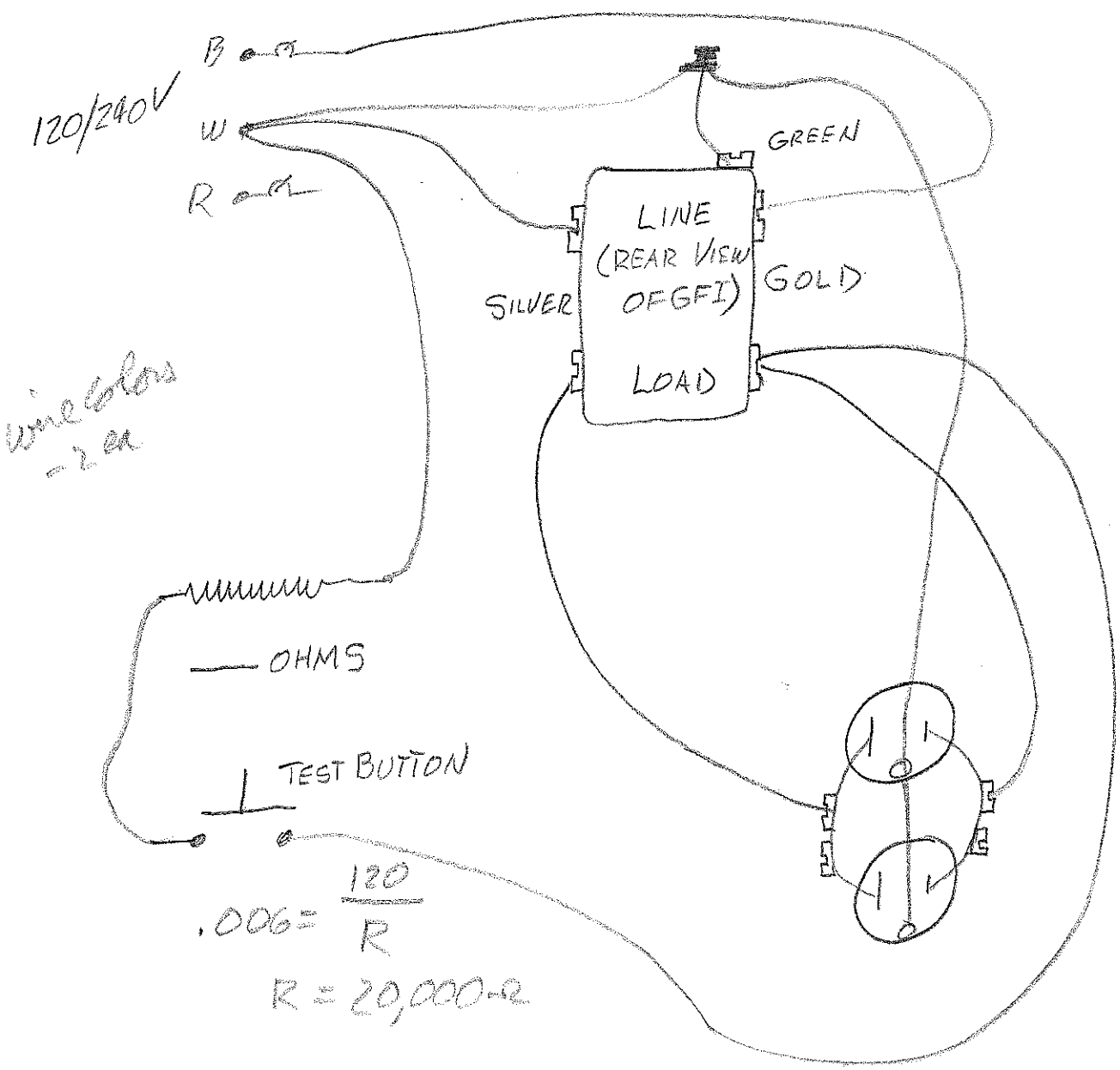
$\theta_E = 66.4 - 0$

$\theta_E = 66.4$

$(62.44)^2(1.53) = 5965\,W$

(20) 21. A 120-V branch circuit serves two receptacles. The first receptacle is a GFI receptacle which is connected so that it also protects the second receptacle.

- Draw the circuit for the branch circuit (including grounding conductor). Show all wire colors .
- This GFI came without a test button, so you need to build one. Draw a circuit which causes a 6-mA inbalance in the GFI when the test button is pressed.



(21) 22. A branch circuit consisting of AWG-6 copper THHN conductors are run in a conduit from a 240-V panel a distance of 44 ft (including 10 % extra) to a 110-A load.

(a) Does the conductor meet ampacity standards? Explain

2 110 A AWG-2 required

No - need AWG 2 - dangerous - will overheat.

(b) What is the voltage across the load with the load turned on, and what is the % voltage drop?

4 $VD = \frac{22(110)(44)}{26240} = 4.06V$ $\frac{240.00 - 4.06}{235.94}$

(c) Compute the watts of power lost by the conductor with the load turned on.

$\frac{4.06}{240} = 1.69\%$ VD

6 $P = (110)(4.06) = 446.6W$

(d) What is the voltage at the load end of the circuit with the load turned off?

240

3

(e) What voltage is available at the load with the load on?

0 b - 235.94

(f) If the load is resistive, by what % does the power use of the load decrease because of voltage drop>

6 $R = \frac{240}{110} = 2.18\Omega$ 3.2% decrease

$P = I^2R = (110)^2(2.18) = 26387$

$I' = \frac{235.94}{2.18} = 108.2A$ $P' = (108.2)^2(2.18) = 25,522W$

Table 5.3. Properties of conductors

Size		area, cmil	usual number of strands	diameter each strand, in.	-----Copper----- weight lb/1000 ft	Resistance*** ohms/1000 ft	-----Aluminum----- Weight lb/1000 ft	Resistance*** ohms/1000 ft
AWG*								
	14	4110	1	0.064	12.5	3.07	3.78	5.06
	12	6530	1	0.081	19.8	1.93	6.01	3.18
	10	10380	1	0.102	31.43	1.21	9.556	2.00
	8	16510	1	0.128	49.98	0.764	15.20	1.26
	6	26240	7	0.061	79.44	0.491	24.15	0.808
	4	41740	7	0.077	126.3	0.308	38.41	0.508
	3	52620	7	0.087	159.3	0.245	48.43	0.403
	2	66360	7	0.097	205	0.194	62.3	0.319
	1	83690	19	0.066	259	0.154	78.6	0.253
	0	105600	19	0.074	326	0.122	99.1	0.201
	00	133100	19	0.084	411	0.0967	125	0.159
	000	167800	19	0.094	518	0.0766	157	0.126
	0000	211600	19	0.106	653	0.0608	199	0.100
kcmil**	250	250000	37	0.082	772	0.0515	235	0.0847
	300	300000	37	0.090	925	0.0429	282	0.0707
	350	350000	37	0.097	1080	0.0367	328	0.0605
	400	400000	37	0.104	1236	0.0321	375	0.0529
	500	500000	37	0.116	1542	0.0258	469	0.0424
	600	600000	61	0.099	1850	0.0214	563	0.0353
	700	700000	61	0.107	2160	0.0184	657	0.0303
	750	750000	61	0.111	2316	0.0171	704	0.0282
	800	800000	61	0.114	2469	0.0161	751	0.0265
	900	900000	61	0.122	2780	0.0143	845	0.0235
	1000	1000000	61	0.128	3086	0.0129	938	0.0212

* American Wire Gage numerical designation
** kcmil = thousands of circular mils
*** DC resistance at 75°C

TABLE 5.7 Minimum copper conductor sizes (AWG or mcmil) for 230-V

Load, in Amps	Ampacity Criterion: In Air, Cable or Conduit: NM,[1] UF,[2] THHW,SE	RH,RHW, TWH,TWHN, THHW,SE	THHN	Direct Burial: UF,[2] USE	Overhead in Air:[3] Single	Triplex or Quad
5	14	14	14	14	10	8
7	14	14	14	14	10	8
10	14	14	14	14	10	8
15	14	14	14	14	10	8
20	12	12	12	12	10	8
25	10	10	10	10	10	8
30	10	10	10	10	10	8
35	8	8	8	8	8	8
40	8	8	8	8	8	8
45	6	8	8	6	8	8
50	6	8	8	6	8	8
60	4	6	6	4	6	6
70	4	4	6	4	4	6
80	3	4	4	3	4	4
90	2	3	4	2	3	4
100	1	3	3	1	3	4
115	1/0	2	2	1/0	2	4
130	2/0	1	2	2/0	1	3
150	3/0	1/0	1	3/0	1/0	1
175	4/0	2/0	2/0	4/0	2/0	2
200		3/0	3/0		3/0	1/0
225		4/0	3/0	4/0	4/0	1/0
250		250	4/0	250	250	2/0
275		300	250	300	300	3/0
300		350	300	350	350	3/0
325		400	350	400	400	4/0
350		500	350	500	500	4/0
375		500	400	500	500	250
400		600	500	600	600	250