

Name Key

TSM 363 - Exam 3

1 - 8 ½ x 11 formula sheet (both sides)
Multiple Choice: 2 points each (40%)

- 1) To use a thermostat to control a heater, connect to
 - a) common and close-on-rise
 - b) common and close-on-fall
 - c) close-on-fall and close-on-rise
 - d) (a) or (b) depending on what temp you are working at

- 2) A + 1
 - a) A
 - b) 1
 - c) 0
 - d) none of the above

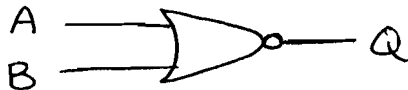
- 3) An electric motor is controlled by a start-stop station through a magnetic motor starter. When the stop button is pushed, the motor stops, but re-starts when the button is released. Probable cause:
 - a) an overload switch stuck open.
 - b) coil short-circuited.
 - c) auxiliary contacts stuck closed.
 - d) auxiliary contacts stuck open.
 - e) none of the above

- 4) Which value is closest to the level of illumination in this room now?
 - a) 0.03fc
 - b) 0.3fc
 - c) 3 fc
 - d) 30 fc
 - e) 300 fc

- 5) An oscilloscope is:
 - a) A device that converts a specific physical quantity such as sound, pressure, strain, or light intensity into an electrical signal.
 - b) A digital electrical component that converts an electrical signal into discrete binary values.
 - c) An instrument used to make voltage changes visible over time.
 - d) A common waveform shape that has a fast rising edge, a width, and a fast falling edge.

- 6) The active element in a humidistat is
- a microswitch
 - a strip of nylon
 - a metal diaphragm
 - a fluid - filled bellows
- 7) How many phase sequences are possible on a 3-phase power system?
- 1
 - 2
 - 3
 - 4
 - 5
- 8) A 4-bit binary number has the following number of possible combinations of 0's and 1's
- $$2^4 = 16$$
- 4
 - 8
 - 12
 - 16
- 9) The line-to-line voltage on a 3-phase wye system is commonly
- 120 volts
 - 208 volts
 - 240 volts
 - 0 volts
- 10) If the lighting level in a room is initially at 100 fc, an increase of 100 fc causes a significant increase in visual effect. If the level was initially at 10 fc, what increase would cause a similar significant increase in visual effect?
- 0.1 fc
 - 1 fc
 - 10 fc
 - 100 fc
 - 1000 fc

11) Draw the symbol for a NOR gate.



- 12) Three equal resistors are connected to form a 3-phase wye load when connected to a 3-phase line. If these same resistors were connected in a delta and connected to the same line, they would use the same power.
- true
 - false
 - it depends on whether the line is wye or delta

13) When the actuating pin is NOT depressed on a microswitch, there is a circuit from:

- a) NO to C
- b) NC to C
- c) NO to NC
- d) C to NO and NC

14) This is NOT an advantage of 3-phase power:

- a) machines are simple and cheap
- b) power flow to a load is constant
- c) conductor costs for transmission lines are reduced
- d) the third circuit conductor eliminates the need for ever having a grounding conductor running up to a load

15) Using words, make a comparison of the outputs of analog devices versus digital devices.

analog - continuous, over a range, gauged
digital - discrete, on or off, numerical

16) A phase-to-neutral RMS voltage exceeding 120V exists on a 120/240-V, 3-phase delta system.

- a) true
- b) false

17) In order to switch a light from 4 locations, these switches are needed:

- a) 2-S, 2-S3
- b) 2-S3, 2-S4
- c) 4-S4
- d) 1-S4, 3-S3

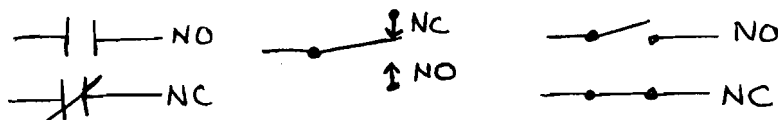
18) Phase voltage and line voltage on a 3-phase system

- a) are always equal
- b) are never equal
- c) are equal on a wye system
- d) are equal on a delta system

19) All repeating waves have the following properties:

- a) A frequency measured in hertz
- b) A period measured in seconds
- c) An amplitude
- d) All the above

20) Draw two different symbols or ways to represent NO/NC contacts.



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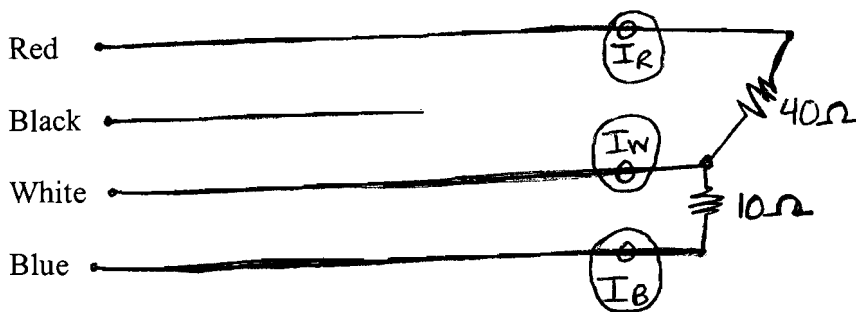
Part 2 – Take Home (open book, open notes, open partner)

Long Essay: (60%)

ATTACH YOUR WORK (boxed answers; no work = no credit)

- 21) Using the frequency of 163 Hz measured from the oscilloscope, convert into the speed of a gear on a motor shaft (revolutions/minute). The gear has 12 teeth.
- In one sentence, compare this calculated value to tachometer measurement of 900 rpm.
 - What is the percent error between measurements?
- 22) A 3-phase delta-wound motor is to use 15 kW and 60 A when connected to a supply with wye transformer. Assume the load is balanced and model the motor as a series RL circuit. Sketch the circuit and compute values for R and X_L . Specify I_L , I_P , E_L , and E_P .

- 23) The Compute the current in the red, blue, and white conductors.
120/208-V 3-phase service
Phase sequence: Blue (0), Black (120), Red (240)



- 24) An electromechanical relay has a 120-volt coil and both NC and NO contacts. Two 240-volt motors are to be switched using the relay. A position switch turns the coil on or off. Motor A is to be on only when the position switch is closed and the thermostat rises about the limit. Motor B is to be on only when the position switch is open or the single cam time clock micro switch changes from the normal position. Draw the ladder diagram of the coil and load circuits.
- 25) Using invertors and NAND gates, draw a circuit with the same response as an OR gate. Prove using a truth table.
- Draw and connect the 7404 inverter and 7400 2-input NAND IC chips to “build” this circuit.

- 26) Draw a circuit which satisfies this equation as is: $Q = Abar[Bbar(B+A) + C]$
- Simplify the equation.
 - Draw a circuit which satisfies the simplified equation.
 - Verify by a truth table that the simplified equation is functionally the same as the original equation.
- 27) Using Table 12.6, what is the recommended illumination for the Howe auditorium where students of all ages will have 1-hour classes and tests using small font sizes? Justify your answer.
- Using the abbreviated Zonal Cavity method, calculate the number of 40-W high efficiency fluorescent bulbs needed if the radius of the auditorium is 50 feet. (Use the area of a circle.)
- 28) Convert 2023_{10} to binary.

Take Home

(21) $163 \text{ Hz} = 163 \frac{\text{cycles}}{\text{sec}} = 163 \frac{\text{teeth}}{\text{sec}}$

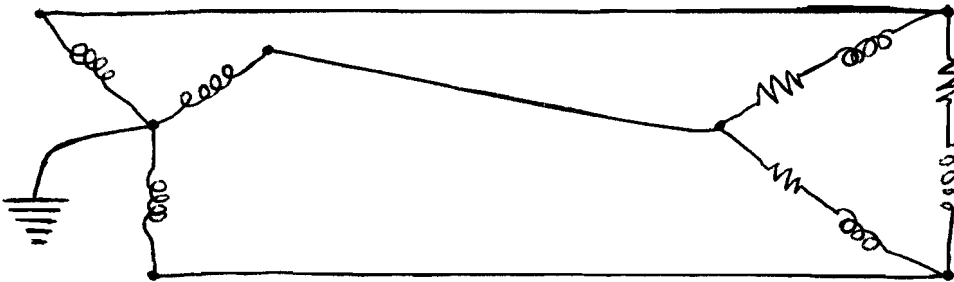
5pts

$$\frac{163 \frac{\text{teeth}}{\text{sec}}}{12 \frac{\text{teeth}}{\text{rev}}} \times \frac{60 \text{ sec}}{1 \text{ min}} = \boxed{815 \frac{\text{rev}}{\text{min}}}$$

b) The calculated value is close to the tachometer measurement but has too much error. Might want to recalculate. experimental

c) $\frac{900-815}{900} (100) = \boxed{9.44\%}$ error

(22)
8pts



WYE

$$E_L = 208V$$

$$I_L = 60A$$

$$P_{3\phi} = \sqrt{3} E_L I_L \cos \theta$$

$$\cos \theta = \frac{P_{3\phi}}{\sqrt{3} E_L I_L}$$

$$\cos \theta = \frac{15000W}{\sqrt{3} (208V)(60A)}$$

$$\cos \theta = 0.6939$$

$$\theta = 46.1^\circ$$

DELTA

$$E_L = E_p = 208V$$

$$I_L = 60A$$

$$I_L = \sqrt{3} I_p$$

$$\frac{I_L}{\sqrt{3}} = \frac{60}{\sqrt{3}} = \boxed{34.64A = I_p}$$

(22 cont.)

Series - Reference I

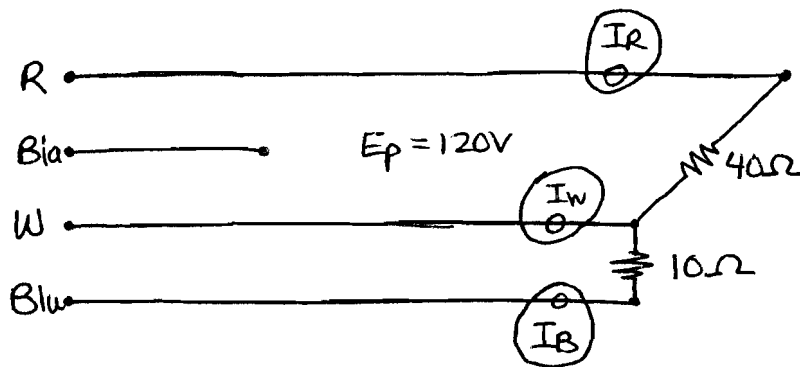
$$Z = \frac{E_p}{I_p} = \frac{208 \angle 46.1^\circ}{34.64 \angle 0^\circ} = 6.00 \angle 46.1^\circ$$

$$R = 6.00 \cos(46.1) = 4.16 \Omega = R$$

$$X_L = 6.00 \sin(46.1) = 4.33 \Omega = X_L$$

(23)

4pts



$$I_R = \frac{E_p}{R} = \frac{120V}{40\Omega} = 3A = I_R$$

$$I_B = \frac{120V}{10\Omega} = 12A = I_B$$



$$I_B = 12 \angle 0^\circ = 12 + j0$$

$$I_R = 3 \angle 240^\circ = -1.5 - j2.60$$

$$I_{RB} = +10.5 - j2.60 = 10.82 \angle -13.9^\circ$$

$$I_W = 10.82 \angle 166.1^\circ$$

$$I_W = 10.82 A$$

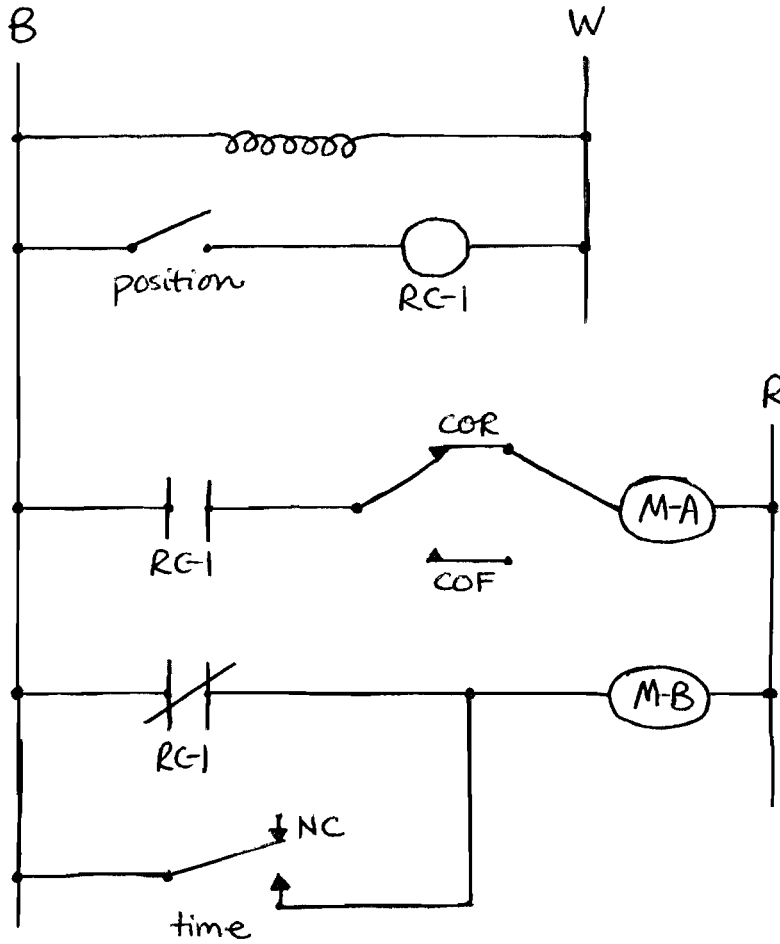
24

9pts

Motor A = NO contact and COR thermostat

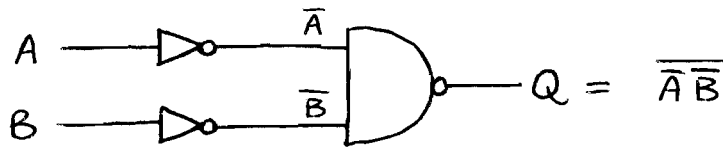
Motor B = NC contact or NO time

* Assume thermostat and time switch in 240V load circuit.



25

9pts

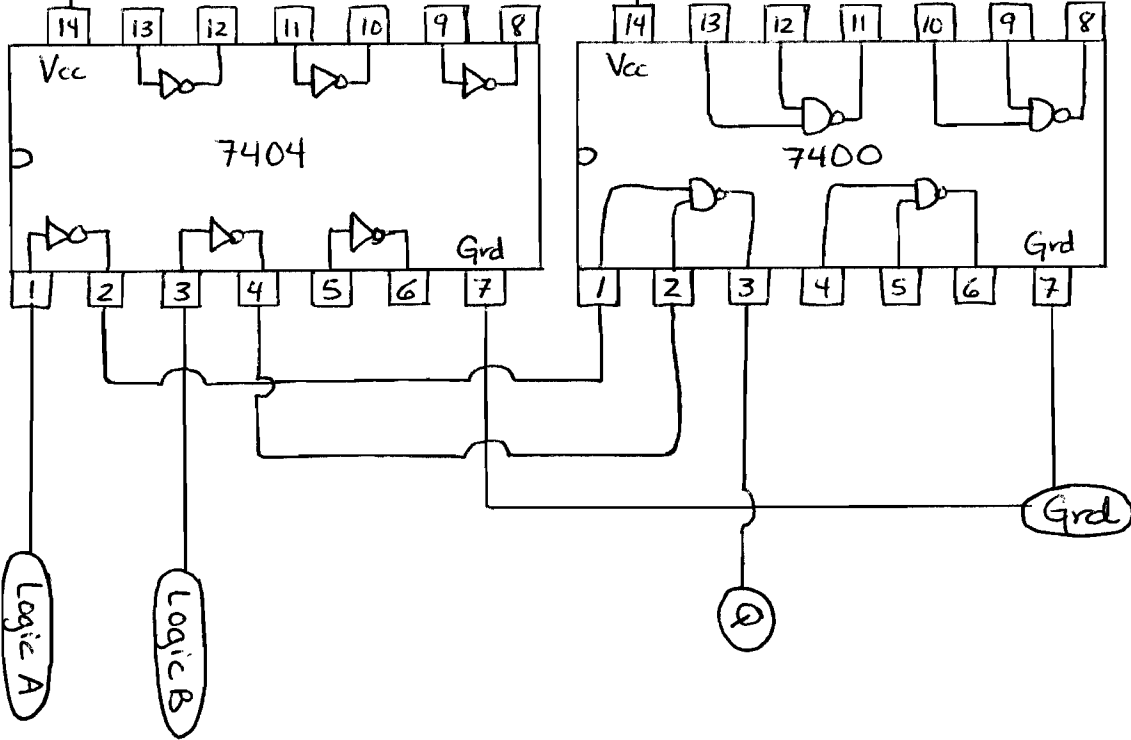


A	B	\bar{A}	\bar{B}	$\bar{A}\bar{B}$	$\overline{\bar{A}\bar{B}}$	A+B
0	0	1	1	1	0	0
0	1	1	0	0	1	1
1	0	0	1	0	1	1
1	1	0	0	0	1	1



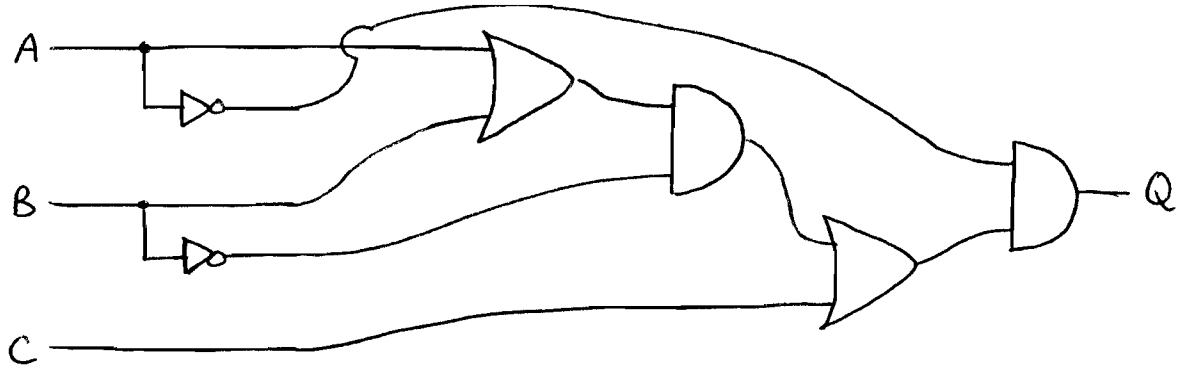
25 cont.

+5Vdc



26 $Q = \bar{A}[\bar{B}(B+A)+C]$

15pts



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(26 cont.)

$$b) Q = \bar{A} [\bar{B}(B+A) + C]$$

$$= \bar{A} [\underbrace{\bar{B}B}_0 + \bar{B}A + C]$$

Distribution

$$= \bar{A} [\bar{B}A + C]$$

Complementation/Intersection

$$= \bar{A}\bar{B}A + \bar{A}C$$

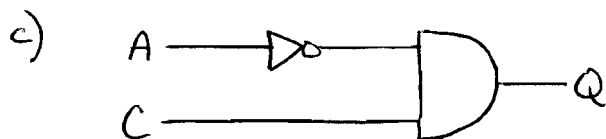
Distribution

$$= \underbrace{\bar{A}A}_0 B + \bar{A}C$$

Association

$$Q = \bar{A}C$$

Complementation/Intersection



d) truth table

A	B	C	\bar{A}	\bar{B}	B+A	$\bar{B}(B+A)$	$\bar{B}(B+A)+C$	$\bar{A}[\bar{B}(B+A)+C]$	$\bar{A}C$
0	0	0	1	1	0	0	0	0	0
0	0	1	1	1	0	0	1	1	1
0	1	0	1	0	1	0	0	0	0
0	1	1	1	0	1	0	1	1	1
1	0	0	0	1	1	1	1	0	0
1	0	1	0	1	1	1	1	0	0
1	1	0	0	0	1	0	0	0	0
1	1	1	0	0	1	0	1	0	0

same \Rightarrow verified

(27) Table 12.6

5pts

Category	E	Small font sizes
Age	+1	All ages
Speed/accuracy	+1	Tests
Reflectance	0	Dull paint but metal desks

+2

100 fc

(27 cont.)

$$b) \quad LL = \frac{IA}{0.5} = \frac{(100 \text{ fc})(\pi(50 \text{ ft})^2)}{0.5} = 1,570,800 \text{ lm}$$

$$\text{Table 12.1} \quad 40\text{-W} = 2580 \text{ lm}$$

$$\frac{1,570,800 \text{ lm}}{2580 \text{ lm}} = 608.84 \sim$$

609 bulbs
40W high- η
fluorescents

(28)

5pts

$$\begin{array}{r} 2023 \\ - 1024 \text{ --- } 2^{10} \\ \hline 999 \\ - 512 \text{ --- } 2^9 \\ \hline 487 \\ - 256 \text{ --- } 2^8 \\ \hline 231 \\ - 128 \text{ --- } 2^7 \\ \hline 103 \\ - 64 \text{ --- } 2^6 \\ \hline 39 \\ - 32 \text{ --- } 2^5 \\ \hline 7 \\ - 4 \text{ --- } 2^2 \\ \hline 3 \\ - 2 \text{ --- } 2^1 \\ \hline 1 \\ - 1 \text{ --- } 2^0 \\ \hline 0 \end{array}$$

1	1	1	1	1	0	0	1	1	1	
10	9	8	7	6	5	4	3	2	1	0

Base 2

