

**EEL4936/6936 – Power Plant Engineering  
Final Exam  
Monday, April 28, 2008  
2 hours in length.**

NAME: \_\_\_\_\_

STUDENT #: \_\_\_\_\_

Section (Please select course number & section number that applies)

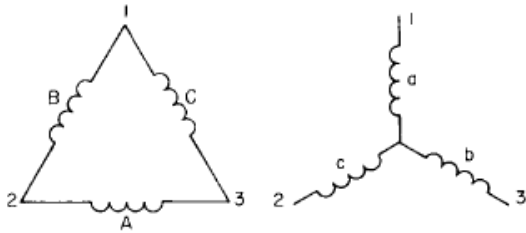
- Course 4936 – Section 797
- Course 4936 – Section 901
- Course 6936 – Section 798
- Course 6936 – Section 901

This exam is open book, open notes, open calculator, and open computer. All class materials provided on website are also. Worked out homework problems **ARE** allowed and encouraged. Copies of homework answer sheets from website **ARE** allowed and encouraged. Please show all work!

**This exam is to be an individual effort.** There is to be **NO** form of communication directly between students. There is to be **NO** passing of paper, pencil, calculator, text book, or any other materials directly between students. Student may ask any questions to moderator / instructor that pertain to clarity of exam questions.

As mentioned on the class syllabus, academic dishonesty of any kind will not be tolerated. If caught cheating, the guilty parties will be subject to **AT LEAST** failure of the course, up to and possibly including expulsion from the University. **DO NOT CHEAT!!!**

1. Given a load configuration below where the load is configured in a delta and each resistance phase to phase is 90 ohms, what is the equivalent line to neutral resistance value?



- A. 90 ohms
- B. 10 ohms
- C. 30 ohms
- D. 3 ohms

Answer C

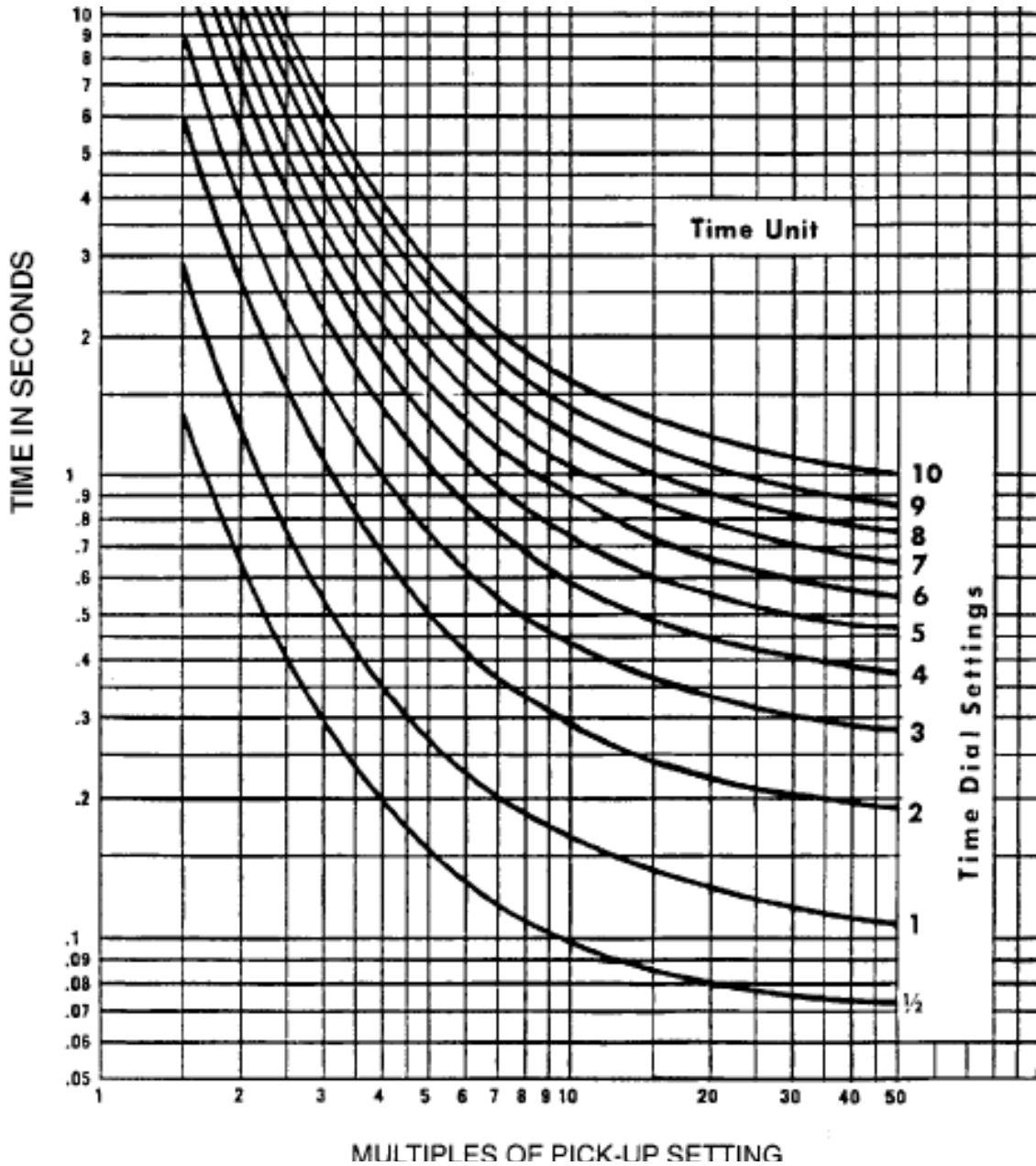
$$a = \frac{B \cdot C}{A + B + C}$$

$$b = \frac{A \cdot C}{A + B + C}$$

$$c = \frac{A \cdot B}{A + B + C}$$

$$a = (90 \cdot 90) / (90 + 90 + 90) = 30 \text{ ohms}$$

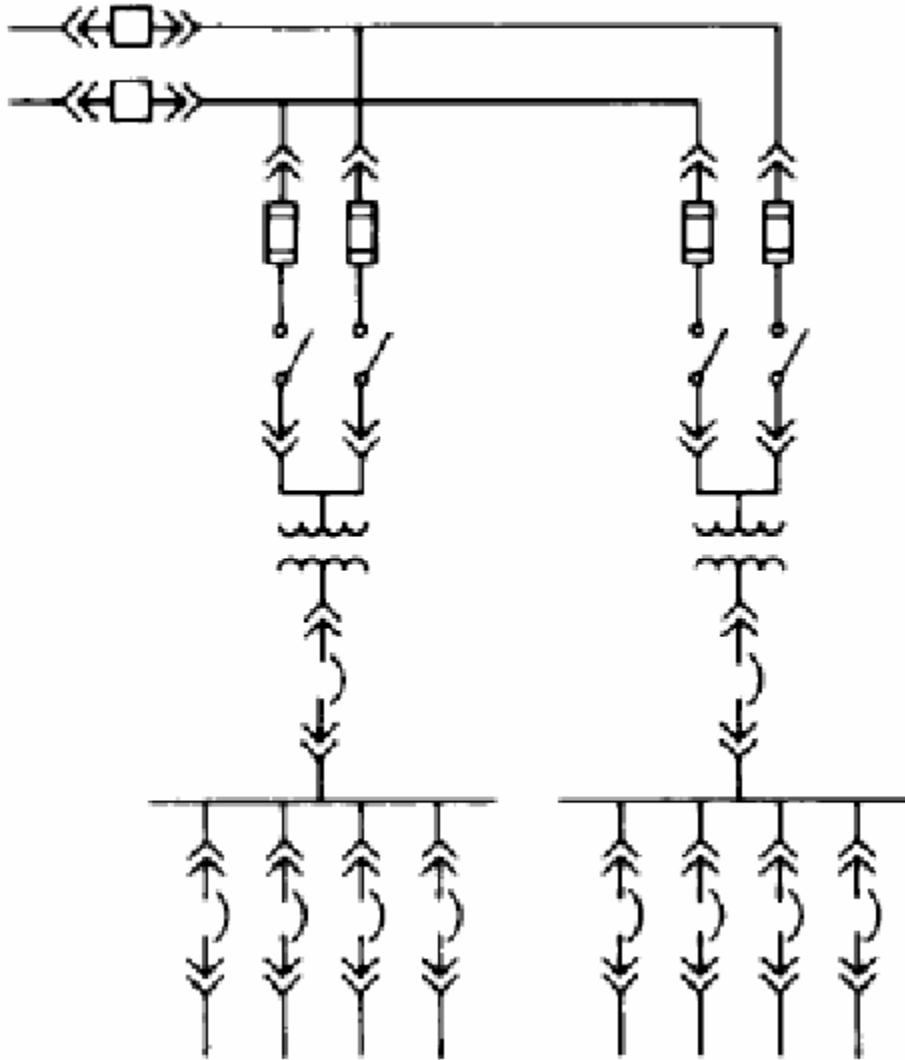
2. For the time delay overcurrent relay shown whose time overcurrent curve is shown below, what is the trip time estimated for a current that is 3 times pickup if the relay is set to time dial 2?



- A. 1.7 seconds
- B. 1.0 seconds
- C. 0.5 seconds
- D. 0.1 seconds

Answer B

3. The system configuration shown below is an example of what type of plant distribution system?



- A. Primary Selective system
- B. Secondary selective system
- C. Loop system
- D. Radial system

Answer A

4. In Ventilated Lead Acid Batteries, the health cell positive plates should be \_\_\_\_\_ and the negative plates should be \_\_\_\_\_.

- A. White, Grey
- B. Grey, Black
- C. Grey, White
- D. Black, Grey

Answer D

5. For a 6 pole motor with 60 Hz applied to stator, runs at full load at 1100 RPM, what is the percent slip of the motor at full load?

- A. 4.17% slip
- B. 4.5% slip
- C. 8.33% slip
- D. 9.09% slip

Answer: C

Percentage of slip =

$[(\text{Synch speed} - \text{FL speed}) / \text{Synch speed}] * 100\%$

$[(1200 \text{ RPM} - 1100 \text{ RPM}) / 1200 \text{ RPM}] * 100\%$

= 8.33 % slip

6. What is the power factor of a motor that has 20 KVA delivered to it and the “real” part of the applied power is 15KW?

- A. 1.0
- B. 0.95
- C. 0.80
- D. 0.75

Answer: D

$\text{PF} = \text{KW} / \text{KVA} = 15\text{KW} / 20\text{KVA}$

$\text{PF} = 0.8$

7. Using table below, find the capacitor rating required to improve the power factor of a 250 kW load from 0.60 to 0.80:

Original power factor	Desired power factor in percent													
	0.80	0.81	0.82	0.83	0.84	0.85	0.86	0.87	0.88	0.89	0.90	0.91	0.92	0.93
0.50	0.982	1.008	1.034	1.060	1.086	1.112	1.139	1.165	1.192	1.220	1.248	1.276	1.306	1.337
0.52	0.893	0.919	0.945	0.971	0.997	1.023	1.050	1.076	1.103	1.131	1.159	1.187	1.217	1.248
0.54	0.809	0.835	0.861	0.887	0.913	0.939	0.966	0.992	1.019	1.047	1.075	1.103	1.133	1.164
0.56	0.730	0.756	0.782	0.808	0.834	0.860	0.887	0.913	0.940	0.968	0.996	1.024	1.054	1.085
0.58	0.655	0.681	0.707	0.733	0.759	0.785	0.812	0.838	0.865	0.893	0.921	0.949	0.979	1.010
0.60	0.583	0.609	0.635	0.661	0.687	0.713	0.740	0.766	0.793	0.821	0.840	0.877	0.907	0.938
0.62	0.516	0.542	0.568	0.594	0.620	0.646	0.673	0.699	0.726	0.754	0.782	0.810	0.840	0.871
0.64	0.451	0.474	0.503	0.529	0.555	0.581	0.608	0.634	0.661	0.689	0.717	0.745	0.775	0.806
0.66	0.388	0.414	0.440	0.466	0.492	0.518	0.545	0.571	0.598	0.626	0.654	0.682	0.712	0.743
0.68	0.328	0.354	0.380	0.406	0.432	0.458	0.485	0.511	0.538	0.566	0.594	0.622	0.652	0.683
0.70	0.270	0.296	0.322	0.348	0.374	0.400	0.427	0.453	0.480	0.508	0.536	0.564	0.594	0.625
0.72	0.214	0.240	0.266	0.292	0.318	0.344	0.371	0.397	0.424	0.452	0.480	0.508	0.538	0.569
0.74	0.159	0.185	0.211	0.237	0.263	0.289	0.316	0.342	0.369	0.397	0.425	0.453	0.483	0.514
0.76	0.105	0.131	0.157	0.183	0.209	0.235	0.262	0.288	0.315	0.343	0.371	0.399	0.429	0.460
0.78	0.052	0.078	0.104	0.130	0.156	0.182	0.209	0.235	0.262	0.290	0.318	0.346	0.376	0.407

- A. 90kvar
- B. 105kvar
- C. 123kvar
- D. 146kvar

Answer: D

Using table above, with original PF=0.6 and desired PF=0.8, the multiplier is 0.583

$$\begin{aligned}
 \text{Kvar} &= \text{kW} * \text{multiplier} \\
 &= 250 * 0.583 \\
 &= 146 \text{ kvar}
 \end{aligned}$$

8. Given a load that has a maximum steady state torque requirement of 100 lb. ft at a rotational speed of 1800 RPM, what is the mechanical power requirement of this application in Horsepower (HP)?

- A. 12 HP
- B. 23HP
- C. 34HP
- D. 46HP

Answer: C

$$\text{HP} = \frac{\text{Torque (lb. ft)} \times \text{RPM}}{5250}$$

$$\text{HP} = 100 \text{ lb. ft} \times 1800 \text{ RPM} / (5250) = 34.3 \text{ HP}$$

9. Given a motor application where the motor full speed is 1800 RPM and is delivering a torque of 200 lb ft to a load through an ideal reduction gear (power in = power out), where the load speed is 450 RPM, what is the amount of torque at the load shaft?

- A. 50 lb ft
- B. 200 lb ft
- C. 400 lb ft
- D. 800 lb ft

Answer: D

$$\text{Torque} = 200 \text{ lb ft} * 1800 \text{ RPM} / 450 \text{ RPM} = 800 \text{ lb ft}$$

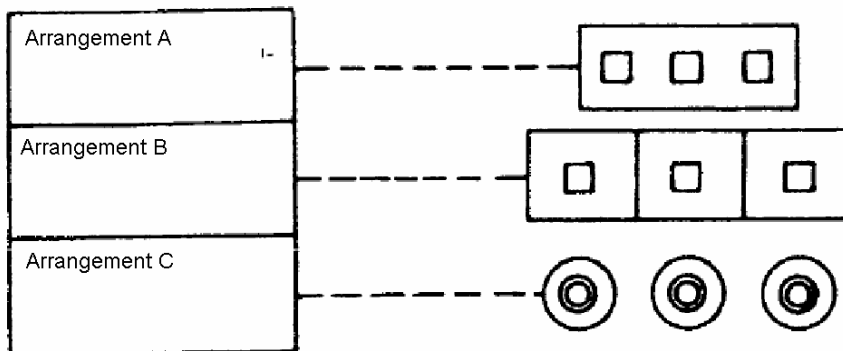
10. Utilizing the table below, if starting a motor using an autotransformer with an initial tap setting of 80% tap, what is the starting torque in percentage of full voltage starting torque?

Type of starter (settings given are the more common for each type)	Motor terminal voltage (percent line voltage)	Starting torque (percent full-voltage starting torque)	Line-current (percent full-voltage starting current)
Full-voltage starter	100	100	100
Autotransformer 80% tap 65% tap 50% tap	80 65 50	64 42 25	67 45 28
Resistor starter, single step (adjusted for motor voltage to be 80% of line voltage)	80	64	80

- A. 100%
- B. 80%
- C. 64%
- D. 50%

Answer C.

11. In the figure below, which figure depicts “isolated phase bus duct”?



**FIGURE 4.6.1** Types of MV busway.

- A. Arrangement A
- B. Arrangement B
- C. Arrangement C

Answer C



12. For a straight pull of 100', pulling a cable weighing 2 lb/ft, what is the pulling tension assuming coefficient of friction to be 0.5?

- A. 50 lb
- B. 100 lb
- C. 150 lb
- D. 200 lb

Answer B

$$T = (2 \text{ lb/ft}) * (100\text{ft}) * 0.5$$

$$T = 100 \text{ lb}$$

13. What is the pull tension for a cable pull through a 60 degree bend where the tension at the bend inlet is 100 lb assuming coefficient of friction to be 0.5?

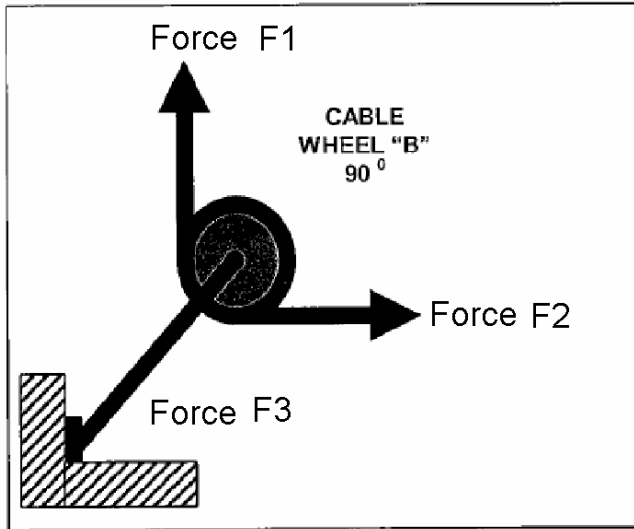
- A. 75 lb
- B. 168 lb
- C. 219 lb
- D. 320 lb

Answer B

$$T_c = 100\text{lb} * \exp(0.5 * (60/57.3))$$

$$T_c = 168 \text{ lb}$$

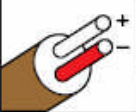

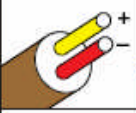

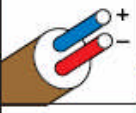

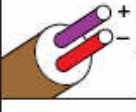

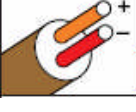

14. Referring to the configuration below, if the value of F1 is 1000 LB and the value of F2 is 1000 LB, what is the value of F3?



- A. 1000 lb
- B. 1414 lb
- C. 2000 lb
- D. 2828 lb

Answer B

#15. You need to replace a thermocouple in a plant process and no information is known on the device. However, when locating the device you see that the conductor color on the positive connection is white and the conductor color on the negative connection is red. Knowing that the plant was built to US standards, what is the type thermocouple you need to use to replace the existing device?

ANSI Code	ANSI MC 96.1 Color Coding		Alloy Combination		Comments Environment Bare Wire	Maximum T/C Grade Temp. Range	EMF (mV) Over Max. Temp. Range
	Thermocouple Grade	Extension Grade	+ Lead	- Lead			
J			IRON Fe (magnetic)	CONSTANTAN COPPER-NICKEL Cu-Ni	Reducing, Vacuum, Inert. Limited Use in Oxidizing at High Temperatures. Not Recommended for Low Temperatures.	-210 to 1200°C -346 to 2193°F	-8.095 to 69.553
K			CHROMEKA® NICKEL-CHROMIUM Ni-Cr	ALOMEGA® NICKEL-ALUMINUM Ni-Al (magnetic)	Clean Oxidizing and Inert. Limited Use in Vacuum or Reducing. Wide Temperature Range, Most Popular Calibration	-270 to 1372°C -454 to 2501°F	-6.458 to 54.886
T			COPPER Cu	CONSTANTAN COPPER-NICKEL Cu-Ni	Mild Oxidizing, Reducing Vacuum or Inert. Good Where Moisture Is Present. Low Temperature & Cryogenic Applications	-270 to 400°C -454 to 752°F	-6.258 to 20.872
E			CHROMEKA® NICKEL-CHROMIUM Ni-Cr	CONSTANTAN COPPER-NICKEL Cu-Ni	Oxidizing or Inert. Limited Use in Vacuum or Reducing. Highest EMF Change Per Degree	-270 to 1000°C -454 to 1832°F	-9.835 to 76.373
N			OMEGA-P® NICROSIL Ni-Cr-Si	OMEGA-N® NISIL Ni-Si-Mg	Alternative to Type K. More Stable at High Temps	-270 to 1300°C -450 to 2372°F	-4.345 to 47.513

- A. Type J
- B. Type K
- C. Type T
- D. Type E

Answer: A

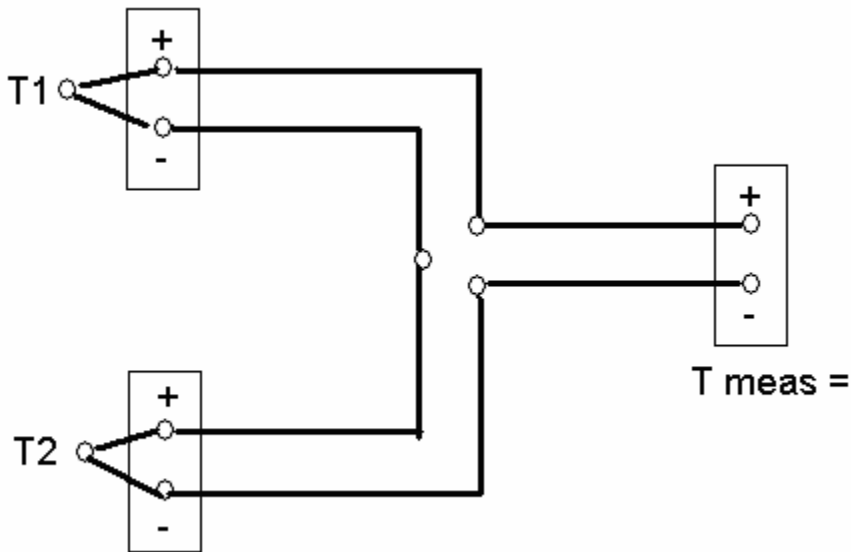
#16. An pressure of 30 psia approximately equals...

- A. 30.0 psig.
- B. 15.3 psig.
- C. 14.7 psig.
- D. 0.0 psig.

ANSWER: B.

#17. With the thermocouple connection shown below, what is the measured temperature (assume cold junction temperature compensation at the measuring end)?

- A.  $T_{\text{meas}} = T_1 + T_2$
- B.  $T_{\text{meas}} = T_1 - T_2$
- C.  $T_{\text{meas}} = T_2 - T_1$
- D.  $T_{\text{meas}} = -T_1 - T_2$



ANSWER: A.

#18. The typical reference resistance of a Platinum RTD is?

- A. 10 OHM
- B. 25 OHM
- C. 100 OHM
- D. 200 OHM

Answer: C

ANSWER: A.

#19. A water storage tank is vented to atmosphere. The tank is located at sea level and contains 100,000 gallons of 80 °F water (specific gravity of 1.0). A pressure gauge at the bottom of the tank reads 10 psig. What is the approximate water level in the tank?

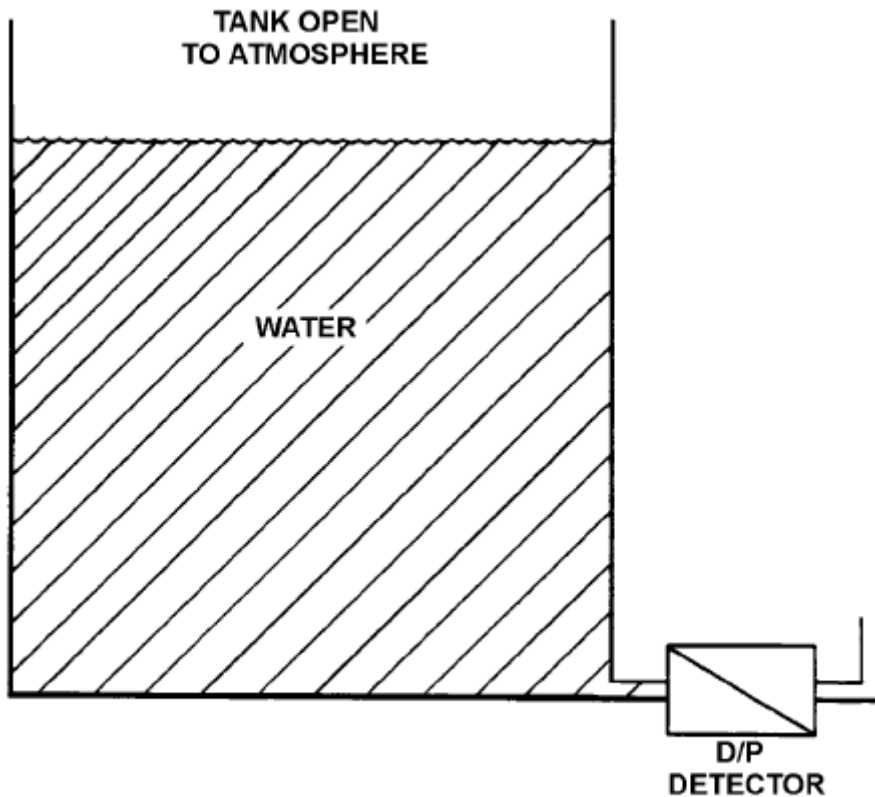
- A. 10 feet
- B. 16 feet
- C. 20 feet
- D. 23 feet

ANSWER: D.

$$H = P / SG * 2.7678$$

Where P = 10 psig and SG for water is 1.0 and 2.7678 inches of water column = 1.0 psig

$$H = 27.7 \text{ inches} = 2.3 \text{ feet}$$



**TANK DIFFERENTIAL PRESSURE LEVEL DETECTOR**

#20. If flow is increased from 100 GPM to 150 GPM in a flow pipe (an increase of 50%) where the flow pipe contains an orifice plate and a differential pressure transmitter to detect flow, what is the increase in differential pressure across the flow plate?

- A. New differential pressure is same as original differential pressure
- B. New differential pressure is 150% times original differential pressure
- C. New differential pressure is 225% times original differential pressure
- D. New differential pressure is 400% times original differential pressure

ANSWER: C.

#21. Utilizing conventional color codes, a circuit breaker that is the color “Light Red” on the HMI indicates that the circuit fed from the circuit breaker is;

- A. Energized and operating
- B. In a faulted condition
- C. De-energized

ANSWER: A.

#22. The formula given below represents the \_\_\_\_\_ function of a PID controller.

$$P = (K_p) * E$$

- A. Percent
- B. Integral
- C. Differential

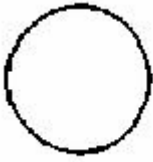
ANSWER: A.

#23 In a balanced draft boiler, the \_\_\_\_\_ fan inlet damper (or fan speed) is used to control boiler pressure (vacuum).

- A. Forced Draft
- B. Induced Draft
- C. Primary Air
- D. Gas Recirculation

ANSWER: B.

#24 The following symbol on a PID (Piping and instrumentation diagram) indicates what?



- A. An instrument located in the field
- B. An instrument located on a local control panel
- C. An instrument behind a local control panel
- D. An instrument mounted in a rack room

ANSWER: A.

#25 Using ISA 5.1 – Instrumentation Symbols and Identification (see handout for lecture 10), the following instrument would be what type of instrument?



- A. A sensitive safety switch
- B. A static safety switch
- C. A speed safety switch
- D. A Secure safety switch

ANSWER: C.

1	C
2	B
3	A
4	D
5	C
6	D
7	D
8	C
9	D
10	C
11	C
12	B
13	B
14	B
15	A
16	B
17	A
18	C
19	D
20	C
21	A
22	A
23	B
24	A
25	C