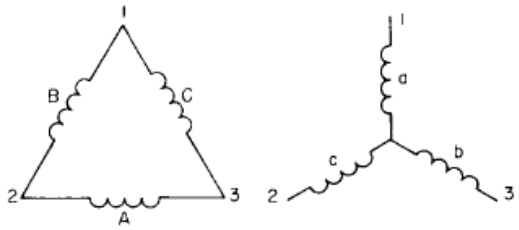
EEL4936/6936 – Power Plant Engineering

Homework #6: Plant Electrical Systems - continued

Due: 04/06/09

1. Given a load configuration below where the load is configured in a delta and each resistance phase to phase is 30 ohms, what is the equivalent line to neutral resistance value?



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

Answer B

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

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

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

a = (30*30) / (30 + 30 + 30) = 10 ohms

2. Given a system and using 480V as your base voltage (Vb) and using 10MVA as your base power (Sb), what is the base current (Ib) for system analysis?

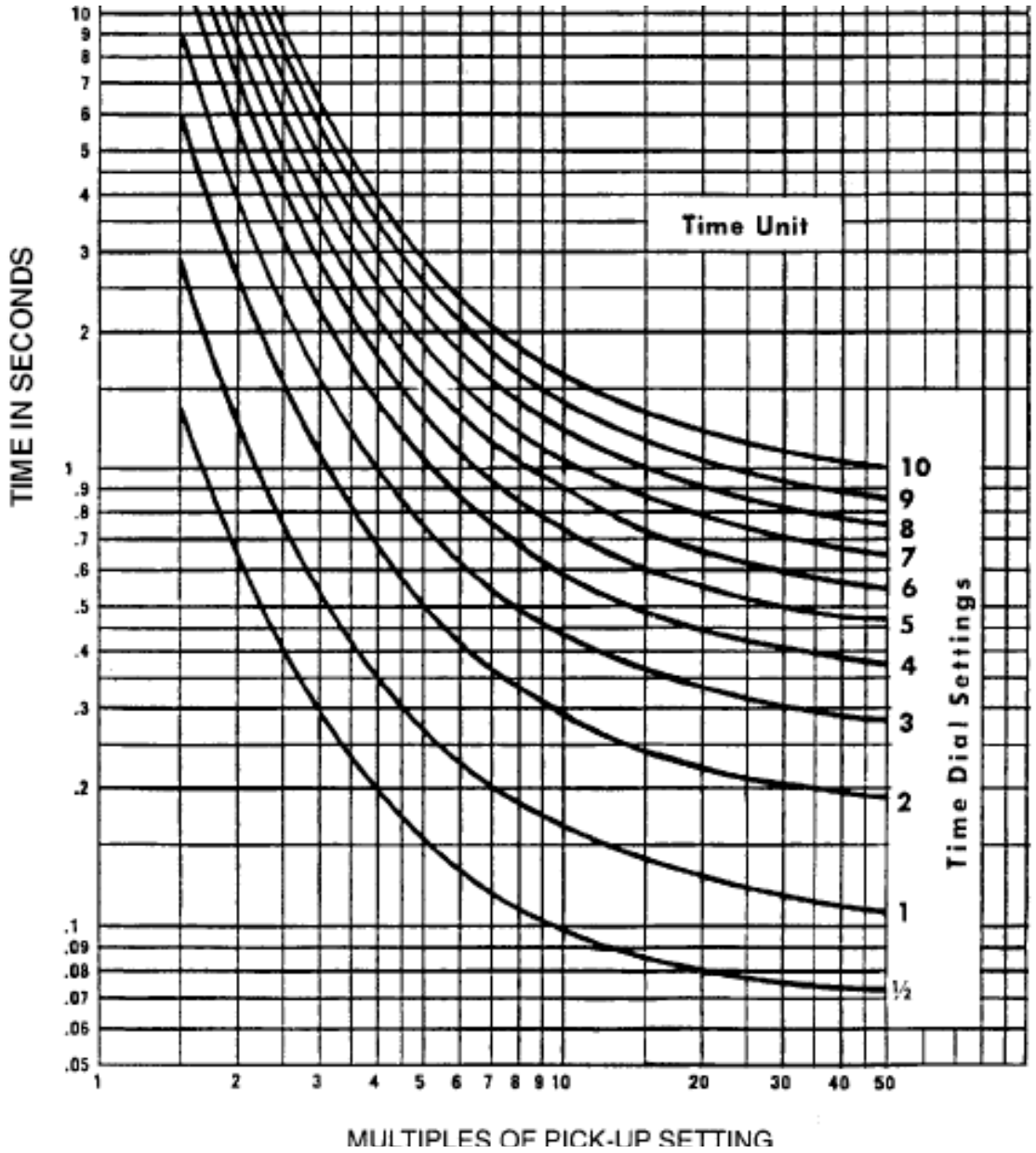
A. Ib = 12 MA
B. Ib = 12 KA
C. Ib = 12 A
D. Ib = 12 mA

Answer: B

Ib = Sb / (1.732 * Vb) =

Ib = 10,000,000 VA / (1.732 * 480) = 12, 028 amps

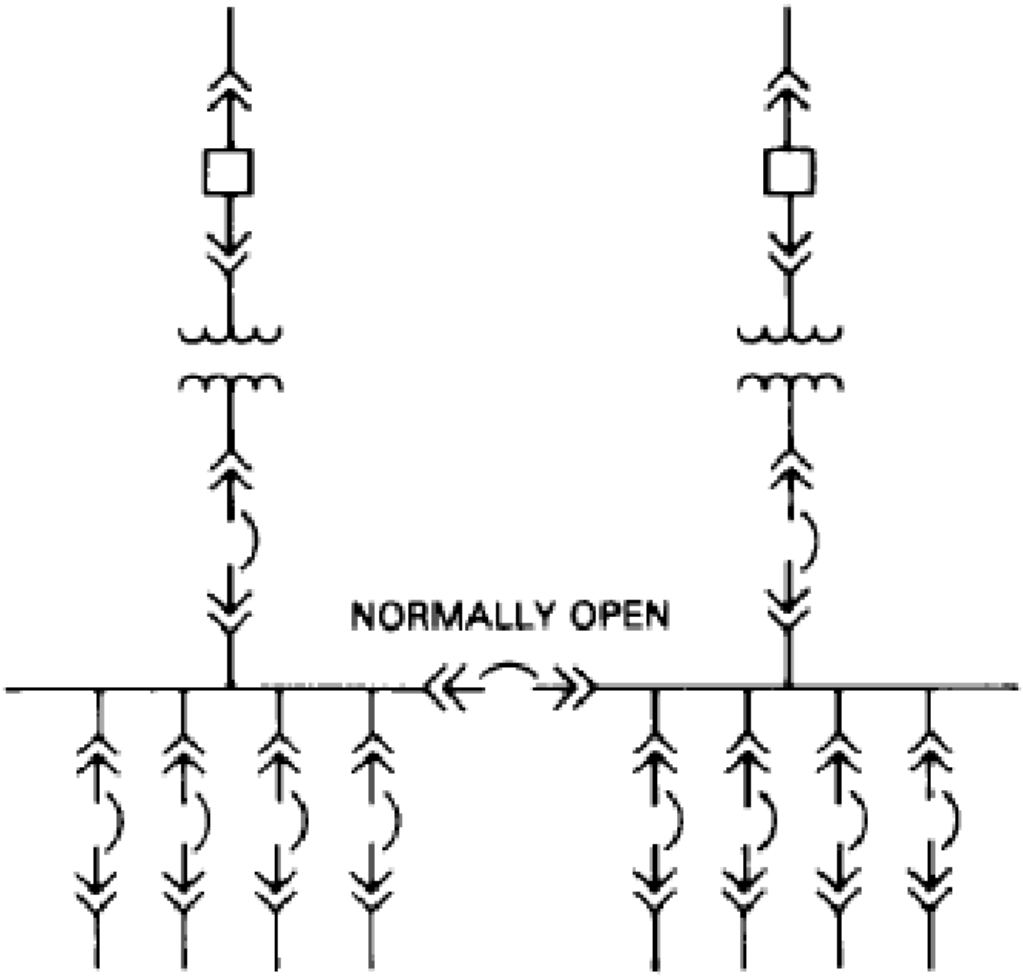
3. For the time delay overcurrent relay shown who's time overcurrent curve is shown below, what is the trip time estimated for a current that is 10 times pickup if the relay is set to time dial 7?



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

Answer B

4. 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 B

5. Ventilated Lead Acid Batteries should be replaced if, during discharge test, the capacity of the battery drops below what percentage of original capacity?

A. 90%
B. 80%

C. 70%
D. 60%

Answer B

6. For a 4 pole, synchronous motor that has 60hz, 480V applied to the stator, what is the synchronous speed of the motor?

A. 3600 RPM
B. 1800 RPM
C. 1200 RPM
D. 900 RPM

Answer: B

Synch speed = 120 * F / P

= 120 * 60 / 4 = 1800 RPM

7. For a 4 pole motor with 60 Hz applied to stator, runs at full load at 1725 RPM, what is the percent slip of the motor at full load?

A. 2.33% slip
B. 3.17% slip
C. 4.17% slip
D. 6.33% slip

Answer: C

Percentage of slip =

[(Synch speed – FL speed)/Synch speed] * 100%

[(1800 RPM – 1725 RPM)/1800 RPM] * 100%

= 4.17 % slip

8. What is the power factor of a motor that has 100 KVA delivered to it and the "real" part of the applied power is 80KW?

A. 1.0
B. 0.9
C. 0.8
D. 0.7

Answer: C

PF = KW/KVA = 80KW/100KVA

PF = 0.8

9. Using table below, find the capacitor rating required to improve the power factor of a 250 kW load from 0.70 to 0.90:

	Desired power factor in percent													
Original power factor	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. 95kvar
B. 123kvar
C. 134kvar
D. 154kvar

Answer: C

Using table above, with original PF=0.7 and desired PF=0.9, the multiplier is 0.536
Kvar = kW * multiplier
= 250 * 0.536
= 134 kvar

10. Given a load that has a maximum steady state torque requirement of 35 lb. ft at a rotational speed of 900 RPM, what is the mechanical power requirement of this application in Horsepower (HP)?

A. 2 HP
B. 4HP

C. 6HP
D. 8HP

Answer: C

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

HP = 35 lb. ft X 900 RPM / (5250) = 6 HP

11. Given an induction motor that has 10HP shaft power at a shaft rotational speed of 1100 RPM, what is the available torque output of the motor at the shaft?

A. 11.9 lb ft
B. 23.86 lb ft
C. 47.73 lb ft
D. 95.45 lb ft

Answer: C

Torque = 5250 * HP / (RPM) = 5250 * 10 / 1100 = 47.73 lb ft

12. Using the same motor application as described in problem 11, if between the motor and the final load a 2:1 gear reduced is utilized, the load shaft speed is HALF of motor shaft speed (i.e. load shaft speed is 550 RPM), and assuming a perfectly efficient gear reducer (i.e. shaft power into gear reduced = shaft power out of gear reducer), What is the torque available on the load shaft downstream of the gear reducer? (hint; use same formula as used in problem 14, but use power and rpm available on load shaft)

Torque = 5250 * HP / (RPM) = 5250 * 10 / 550 = 95.45 lb ft

A. 11.9 lb ft
B. 23.86 lb ft
C. 47.73 lb ft
D. 95.45 lb ft

Answer: D

Torque = 5250 * HP / (RPM) = 5250 * 10 / 550 = 95.45 lb ft

13. The method of reduced voltage starting where the LINE current is reduced proportional to the SQUARE of the reduction of voltage is;

A. Autotransformer

B. Primary resistor
C. Primary reactor

Answer A.

14. A variable frequency drive adjusts applied _____ to a motor stator to control the speed of the motor and adjusts applied _____ to a motor to control the available motor torque.

A. Voltage; Frequency
B. Frequency ; Voltage

Answer B

15. In the figure below, which figure depicts “segregated phase bus duct”?

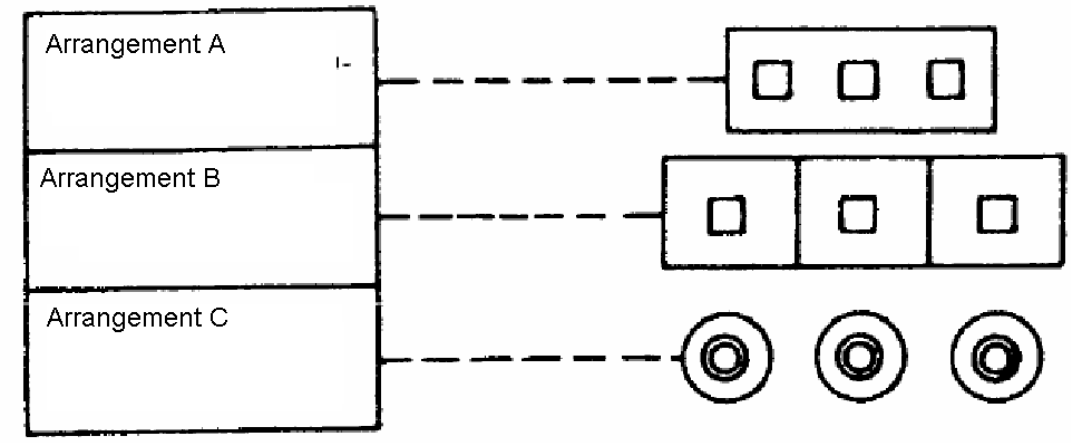


FIGURE 4.6.1 Types of MV busway.

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

Answer B

16. For a straight pull of 200’, pulling a cable weighing 1 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 = (1 lb/ft) * (200ft) * 0.5

T = 100 lb

17. What is the pull tension for a cable pull through a 90 degree bend where the tension at the bend inlet is 100 lb assuming coefficient of friction to be 0.5?

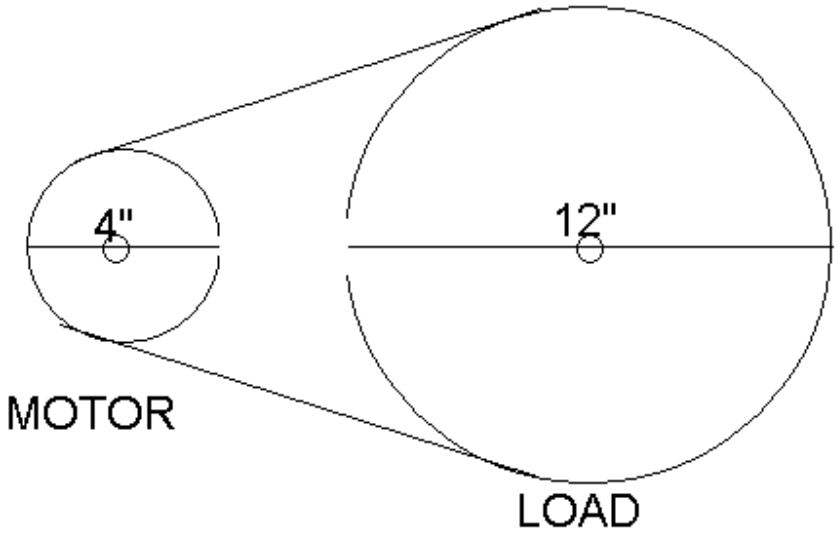
A. 59 lb
B. 159 lb
C. 219 lb
D. 319 lb

Answer C

Tc = 100lb * exp (0.5 * (90/57.3))

Tc = 219 lb

18. A transmission system as shown below has a pulley with a diameter of 12” on the load shaft and a pulley with a diameter of 4” on the motor shaft. If the torque the load is requiring is 60 lb ft, what is torque on the motor shaft? (Assume an ideal transmission system where Pin = Pout)



A. 15 lb ft
B. 20 lb ft
C. 30 lb ft
D. 60 lb ft

Answer: B

Torque Motor = Torque load * (D motor / D load)

= 60 lb ft * (4” / 12”) = 20 lb ft