Exemplars are excerpts from practice problems for early versions and styles of Principles and Practices exams.
The following applications contain excerpts from *Electrical and Computer Engineering Sample Questions and Solutions*, by the National Council of Examiners for Engineering and Surveying.

1 – Safety

1. Complete the safety questions sheet in Chapter 1.

2 – Electrical Magnetic

1. Write the electrical magnetic energy equation in node form.
2. Write the electrical magnetic energy equation in volume field form.

3 – Elements

1.

3 – Magnetics

3. Given: Laminated iron core

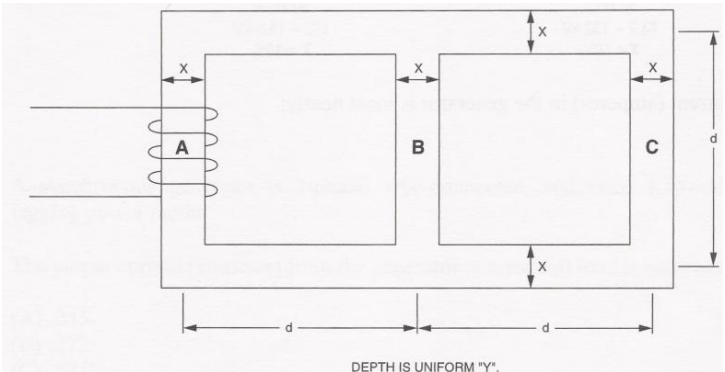
depth of core	.05 m
width of core	.05 m
length of air gap	.0007 m
effective length of core	0.3 m
relative permeability of Fe	2000
air gap flux density	0.5 T
number of turns	200

Find:

a. total flux _____
b. flux density in the iron _____
c. magnetic intensity in the iron _____
d. total mmf required on the core _____
e. current required on the core _____

116. A dc current of 50 A is flowing in a long isolated wire. The magnitude of the magnetic field intensity, H (A/m), 10 cm from the center of the wire is most nearly:
(A) 0.001
(B) 8
(C) 80
(D) 250

516. Consider the three-legged magnetic circuit in the figure, fabricated with a homogeneous iron core and a uniform cross-sectional area. With the coil energized, the magnetic flux in Leg A is 3.0 X 10-3webers (Wb). Assuming



linear magnetic properties, the approximate flux (Wb) in Leg C is most nearly:
(A) 0.5 X 10-3
(B) 0.75 X 10-3
(C) 1.0 X 10-3
(D) 2.0 X 10-3

4 – AC

133. A single-phase transformer serves a 7.2-kW resistive load located 200 ft from the transformer. Each conductor from the transformer to the load has an impedance of (0.78 + *jO.052)* Ohm per 1,000 ft. If the voltage at the load terminals is 240 V, the voltage magnitude (V) at the transformer secondary is most nearly:
(A) 265
(B) 250
(C) 245
(D) 230

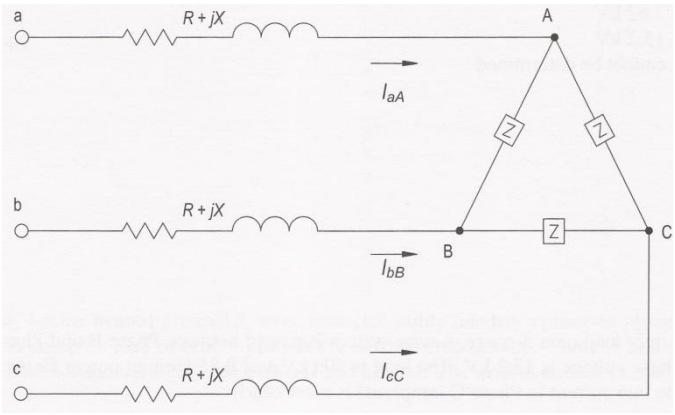
135. The 3-phase load at a bus is 8,000 kW at 0.80 lagging power factor. The total reactive power (kvar) supplied by a 3-phase capacitor bank that will increase the power factor to 0.95 lagging is most nearly:
(A) 6,000
(B) 3,400
(C) 2,900
(D) 2,600

508. A 3-phase, 4-wire, neutral-grounded, wye-connected utility line has a phase-to-phase voltage of 13.2 kV. A complex load of (200 *+jl00)* kVA is connected between Phase A and neutral. An identical load is connected between Phase B and neutral. The neutral current (amperes) is most nearly:
(A) 0
(B) 9.8
(C) 16.9
(D) 29.3

509. A 3-phase, 3-wire, ungrounded, 13.2-kV (phase-to-phase) wye-connected source is connected to a balanced delta load that is grounded on Corner A. The voltage measured between Corner B and ground is most nearly:
(A) half the phase-to-phase voltage
(B) 7.62 kV
(C) 13.2 kV
(D) cannot be determined

510. The only load on a 3-phase, 4-wire system is placed between Phase B and Phase C. The phase to phase voltage is 13.2 kV. The load is 500 kVA at 0.85 lagging power factor. The magnitude of the line current in Phase C (amperes) is most nearly:
(A) 65.6
(B) 55.8
(C) 37.9
(D) 32.2

511. The figure below represents a balanced 3-phase distribution system, sequence ABC, 60 Hz. *VAB*= 12.5 *LO°* kV (load voltage), and the impedance of the line is (5 *+jl0)* Ohm/phase. If *IaA= 70L-20°*, then the magnitude *Vab* in kV is most nearly:
(A) 15.0
(B) 13.8
(C) 13.0
(D) 11.9

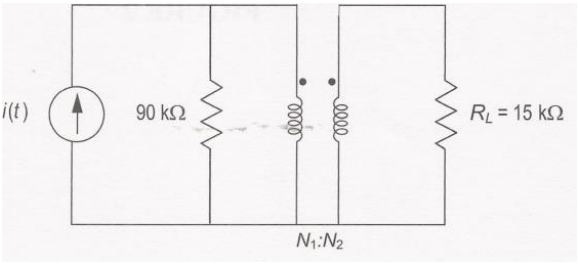


5 – Models

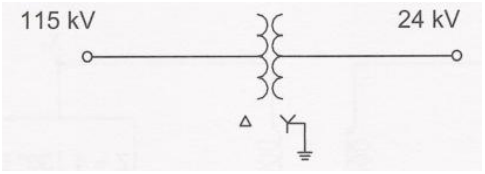
123. A loudspeaker with an electrical impedance of 8 Ohm resistive has an efficiency of 15%. If the terminal voltage is 30V_{rms}, the acoustic output (W) is most nearly:
(A) 4.5
(B) 17
(C) 36
(D) 135

6 – Transformers

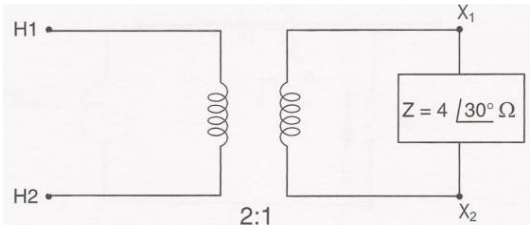
115. A transducer which is modeled as a Norton equivalent is coupled to a load resistance, R_L, by an ideal transformer. To obtain maximum power transfer from the transducer to the load, the turns ratio N1:N2 is most nearly:
(A) 1:6
(B) 2.5: 1
(C) 6:1
(D) 36:1



138. The one-line diagram below represents three single-phase transformers connected in a delta/wye arrangement and rated for the line-to-line voltages indicated as shown below. The turns ratio of individual single-phase transformers is most nearly:
(A) 2.8
(B) 4.8
(C) 8.3
(D) 14.4



140. Consider the lossless ac transformer shown in the figure. The steady-state impedance seen between Terminals H1-H2 is most nearly:
(A) l *L*30°
(B) 8 *L*-30°
(C) 16 *L*-150°
(D) 16 *L*30°



501. A SCADA system configuration requires maximum values (i.e., the actual value of current when the transducer is at full scale). The transducer has a full-scale ac current of 5 A. Using a current transformer with a turns ratio of 400:5, the maximum value of current (amperes) is most nearly:
(A) 1,200
(B) 800
(C) 400
(D) 300

502. A differential relay circuit connected to protect a delta-wye transformer using current transformers (CTs) must be balanced with properly connected auxiliary CTs to allow for the 30° phase shift and the turns ratio. If this is not accomplished, which of the following is most correct?
(A) The circuit could cause the relay to be picked up under non-fault conditions.
(B) The American national standard for designating terminals HI and Xl on wye-delta transformers would not be followed.
(C) A positive-sequence voltage drop from Bushing HI to the neutral would lead the positive sequence voltage drop from Bushing Xl to the neutral by more than 30°.
(D) The delta winding must be located on the high-voltage side of the transformer.

525. Two single-phase transformers with identical voltage ratings are proposed to be connected in parallel to serve a load. The following rating and impedance data are provided:
Transformer 1: 1,000 kVA, Z= 4.5%
Transformer 2: 2,000 kVA, Z = 6.0%
The maximum total load (kVA) that can be served by the bank without overloading either transformer is most nearly:
(A) 2,333
(B) 2,500
(C) 2,667
(D) 3,000

526. Two 3-phase transformers are proposed to be connected in parallel to serve a large load. Transformer 1 is wye-delta, and Transformer 2 is wye-wye. Which of the following statements is most correct?
(A) The transformers should not be paralleled.
(B) The transformers may be. paralleled if the neutral of Transformer 2 secondary is unconnected and the turns ratio of Transformer 2 is 1.732 times the turns ratio of Transformer 1.
(C) The transformers may be paralleled if the neutral of Transformer 2 secondary is unconnected and the turns ratio of Transformer 1 is 1.732 times the turns ratio of Transformer 2.
(D) The secondary neutrals of Transformer 1 and 2 mayor may not be connected, but the transformer turns ratios, impedances, and kVA ratings must be matched to achieve maximum output.

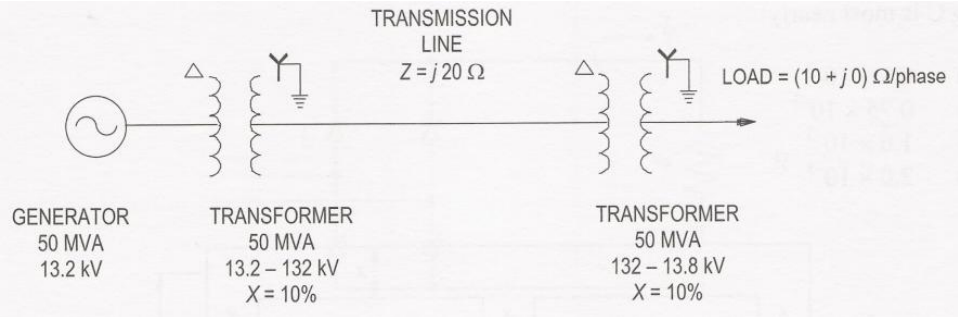
7 – DC

520. A dc shunt motor has a nameplate rating of 150 hp, 600 V, 200 A, 1,750 rpm. Assuming a no-load speed of 1,790 rpm, the speed regulation is most nearly:
(A) 2.2%
(B) 2.3%
(C) 2.5%

(D) 3.0%

8 – Synchronous

518. A 3-phase, 60-Hz transmission system is shown in the figure below. The transmission line current is 75.93 A. The load current (amperes) in the generator is most nearly:
(A) 760
(B) 1,320
(C) 2,090
(D) 2,190



521. A synchronous generator is 3-phase, wye-connected, and rated 1,131 kVA, 2.4 kV, 0.90 lagging power factor. The output current (amperes) from the generator at rated full load is most nearly:
(A) 245
(B) 272
(C) 424
(D) 471

522. A power plant uses a turbine-driven synchronous generator rated 3-phase, 150MVA, 13.8 kV, 0.85 lagging power factor. At rated conditions the real power output (MW) is most nearly:
(A) 60
(B) 75
(C) 128
(D) 150

9 – Induction

134. A 3-phase, 460-V, 25-hp induction motor draws 34 A at 0.75 lagging power factor from a 480-V source. The reactive power (kvar) required to correct the power factor to 0.90 lagging is most nearly:
(A) -2.8
(B) -4.9
(C) -8.4
(D) -14.6

139. A 3-phase, 60-Hz induction motor has a nameplate speed of 1,600 rpm. This motor has how many poles?
(A) 2.0
(B) 4.0
(C) 4.5
(D) 6.0

519. An induction motor is rated at 1,000 hp, 1,165 rpm, 2.4 kV, 201 A, 3-phase, 60 Hz, 0.94 lagging power factor at full load. If the starting torque of the motor is 150% of full-load torque, then the starting torque (ft-Ib) is most nearly:
(A) 4,510
(B) 5,250
(C) 6,020
(D) 6,760

523. A 3-phase induction motor draws 28.0 A at no-load and 92.0 A at full-load. The power factor of the motor at half-load is most nearly:
(A) 0.61
(B) 0.64
(C) 0.71
(D) 0.84

524. A large 3-phase induction motor is to be specified. Which of the following design features would be most helpful in reducing peak starting-current requirements?
(A) Use of a high-efficiency, Design E motor
(B) Starting the motor unloaded and then connecting the driven device with a clutch after the motor has accelerated
(C) Use of a motor with a higher service factor
(D) Use of a wye-start, delta-run motor

531. A 3-phase capacitor rated at 240 V and 110 kvar has been proposed for correcting the power factor of a 3-phase induction motor operating at 208 V. The kVAr that will be provided by the capacitor is most nearly:
(A) 82.6
(B) 95.3
(C) 110
(D) 127

528. Which of the following conditions would most likely result in a saturated magnetic flux within the indicated equipment?
(A) A 50-Hz power transformer operated at 60 Hz and at rated MVA
(B) A 3-phase induction motor driven by an inverter at the rated voltage of the motor and half its rated frequency
(C) A power transformer, operating at rated MVA, connected delta to a long transmission line that is exposed to a heavy geomagnetic solar storm
(D) A current transformer with its primary carrying rated current and its secondary winding shorted

10 – Induction tutorial

1. For a 480 V, 52 amp, 3-phase motor, what would be the transformer KVA required?

2. For a 40 Hp, 460 V motor, what is
(a) full load current?
(b) maximum starting (locked rotor) current?
(c) running current?

3. What enclosure is used for
(a) high pressure water injection plant?
(b) inadequately ventilated enclosed LACT unit?

4. For a 40 Hp, 1200RPM, ODP motor built in 1980, what is
(a) NEMA frame?
(b) shaft size?

5. For a 6 pole, 60 HZ, 5% slip motor, what is
(a) synchronous speed?
(b) rotor speed?

6. Can a motor used on a waterflood plant be used on a pumping unit?
Why?

7. For a beam pumping unit in Texas requiring 31 Hp, what would be the following?
(a) horsepower
(b) voltage
(c) number of phases
(d) frequency
(e) synchronous speed
(f) application
(g) enclosure
(h) coupling

8. For a motor that operates at 460 v and 52 amps, what is
(a) power factor at 33000 watts input?
(b) motor load?
(c) size motor?
(d) power factor at 15000 watts input?

9. For a motor in a 10% methane environment, what is
(a) Class?
(b) Division?
(c) Group?

10. For a TEFC motor with class B insulation, can the motor be safely operated with an ambient of 50oC?
Why?

11. Select the best bearing (anti-friction or sleeve) for the application.
(a) Vertical mounting
(b) Offset coupling
((c) Quiet room

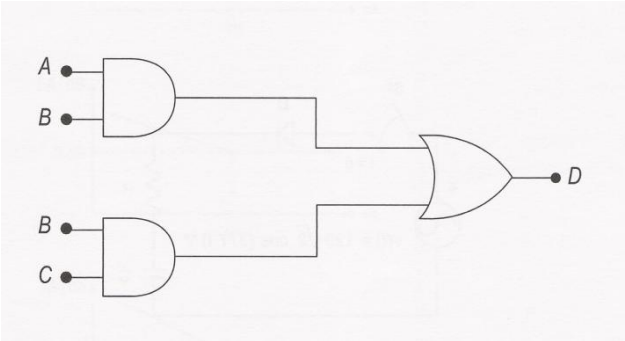
12. How often should a 1200, 40 Hp motor be lubricated
(a) in normal pumping service?
(b) in heavy cyclic service?

13. For a 40 Hp, 1200 RPM motor, and a conversion factor of 5250, what is
(a) torque?
(b) torque per horsepower?

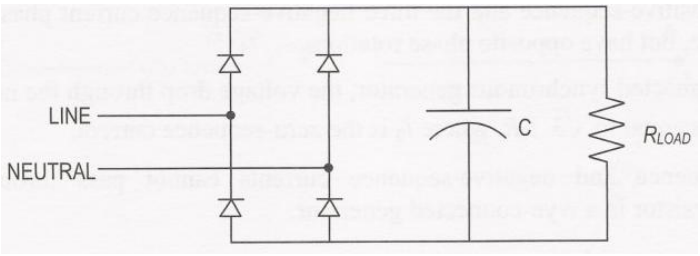
14. For a motor with applied voltages of 450, 460, 470 volts, what is
    (a) average voltage?
    (b) maximum voltage deviation?
    (c) voltage unbalance?
    (d) horsepower derating?

11 – Controls

117. The output *D* in the circuit is:
(A) *B(A* + C)
(B) *(A* + *B) (B* + C)
(C) *AB* + *BC*
(D) *(A* +*B)CB*

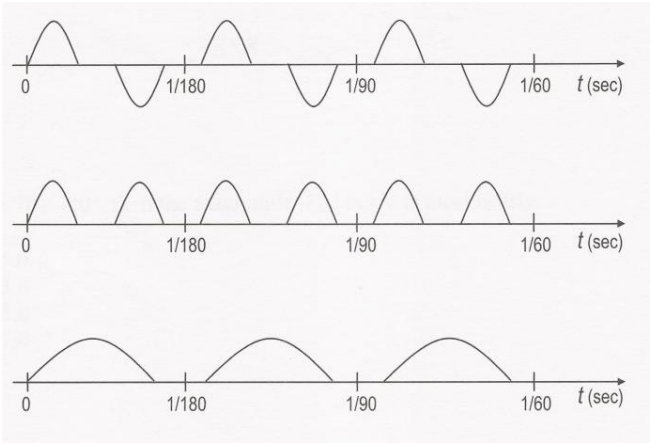


513. Consider a 208/120 V, 3-phase, wye-connected, 4-wire transformer. Each 120-Vphase feeds a separate and identical dc power supply comprising a simple full-wave bridge rectifier, followed by a large filter capacitor. There are a total of three dc power supplies, one connected to each phase. The following circuit diagram shows one of the three power supplies:



The outputs of the three power supplies are loaded with identical resistive loads. There are no other loads on the transformer. Which of the following oscilloscope traces of the neutral current is most likely to be observed?

A

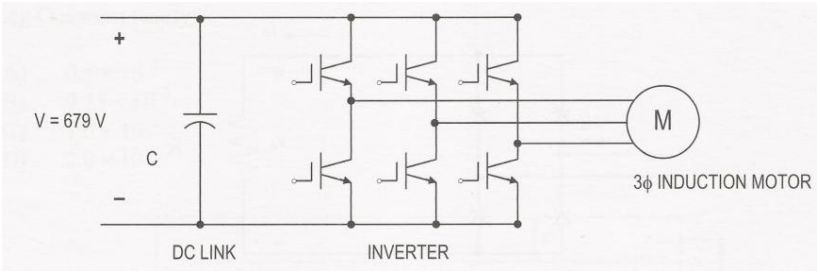


B

C

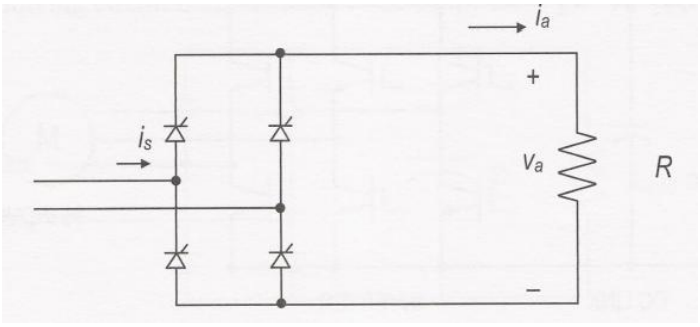
D. The trace is essentially flat.

514. The following inverter schematic is used for a variable-speed motor drive. Assume ideal transistors. Each transistor operates as an ideal switch. The peak phase-to-phase voltage (V) to the motor is most nearly:
(A) 336
(B) 475
(C) 480

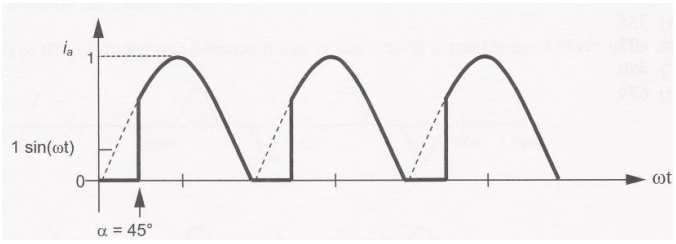


(D) 679

515. A single-phase, 60-Hz, fully controlled thyristor bridge operates with a purely resistive load. In the figure shown below, *ia* is the output current, *Va* is the output voltage, and the input current is
designated as *is.*



The output waveform is illustrated here:



The average value of the output current *ia*(amperes) is most nearly:
(A) 0
(B) 0.543
(C) 0.637
(D) 0.707

12 – Protection

104. To reduce electrical shock hazard, the grounded neutral conductor in a separately derived 3-phase *480Y/277* V distribution system should be electrically bonded to:
(A) the grounding electrode conductor and the equipment grounding conductor at the service equipment or source
(B) a grounding electrode conductor whenever possible at panels on the load side of the service equipment or source
(C) the equipment grounding conductor at each panel board on the load side of the service equipment or source
(D) all of the above

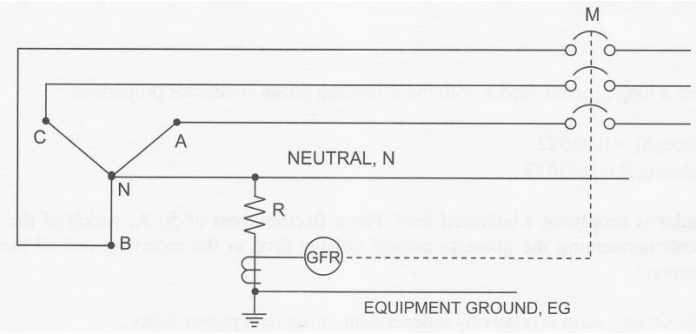
105. A single-phase, 120-VAC branch circuit is properly protected by a circuit breaker and a ground-fault circuit interrupter (GFCI). Which of the following electrical hazards is least protected?
(A) Short circuit
(B) Overload
(C) High-resistance fault, phase-to-ground
(D) Line-to-neutral shock

137. The equipment-grounding conductor for an electrical distribution system within a building is the conductor that connects noncurrent-carrying parts of equipment and raceways to ground at the service equipment or the source of a separately derived system. The purpose of an equipment-grounding conductor is to provide a:
(A) low impedance to ground to limit voltage to ground on exposed conducting surfaces and help ensure ground fault clearing
(B) path to ground for all harmonic currents
(C) path to ground for triplen harmonics
(D) low impedance to ground to limit voltage t(} ground on exposed conducting surfaces, help ensure ground fault clearing, and provide a path to ground for triplen harmonics

503. An industrial plant is served by a 12,470-V M480-V grounded-wye transformer. The high voltage side of the transformer is served from a 12,470-V wye-connected distribution line that has a grounded neutral. The best protection of the transformer against lightning strikes on the 12,470-V line will result from surge arrester connections of:
(A) phase to ground on the 12,470-V side of the transformer
(B) phase to phase on the 12,470-V side of the transformer
(C) phase to ground on the 480-V side of the transformer
(D) phase to neutral to ground on the 480-V side of the transformer

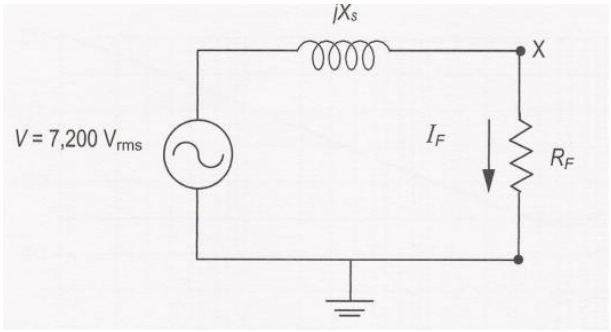
533. The maximum resistance to ground (Ω) of a single grounding electrode without the requirement to add an additional grounding electrode that is found in the *National Electrical Code* is:
(A) 5
(B) 20
(C) 25
(D) 50

534. The circuit represented in the figure below is a ground-fault protection scheme.
The purpose of R is to:
(A) limit the ground current and prevent damage
(B) maintain a potential difference between N and EG
(C) decrease the interrupting rating required of M
(D) A, B, and C are correct



13 – Transmission

136. The diagram below represents the Thevenin equivalent of a single-phase distribution system. A fault occurs between point X and ground. R_F represents the fault resistance. The current I_F is 3,600 A when R_F is 0 Q. If R_F is changed to 1.0 Q, the current I_F (amperes) is most nearly:
(A) 2,000
(B) 2,400
(C) 3,200
(D) 4,600



507. A 3-phase transmission line is rated 65 kV and 24 MVA. The line impedance is 50 Ohm/phase. Assuming the line-rated values are also the base values, the per-unit impedance is most nearly:
(A) 0.167
(B) 0.284
(C) 3.52
(D) 18.46

512. When using the method of symmetrical components, which of the following statements is most nearly correct?
(A) The three zero-sequence current phasors are equal in magnitude and displaced by 120°.
(B) The three positive-sequence and the three negative-sequence current phasors are all equal in magnitude, but have opposite phase rotations.

(C) In a wye-connected synchronous generator, the voltage drop through the neutral grounding resistor, *R*, is equal to *ıo√3 IoR*, where *Io* is the zero-sequence current.
(D) Positive-sequence and negative-sequence currents cannot pass through the neutral grounding resistor in a wye-connected generator.

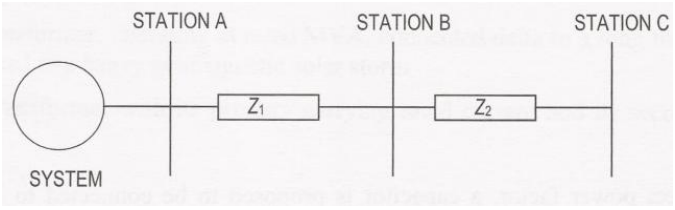
517. A 3-phase distribution line conductor configuration is as follows: The 12-kV distribution line conductor geometric mean distance (feet) for the crossarm framing
shown is most nearly:

•←3 ft→•←4 ft→•

(A) 3.5
(B) 4.0
(C) 4.4
(D) 5.0

527. A transformer is rated 3-phase, 25 MVA, 66-12.47 kV, delta-wye connected, 8% impedance. On a 100-MVA base, the per-unit impedance is most nearly:
(A) 0.08
(B) 0.16
(C) 0.24
(D) 0.32

532. Consider the 60-kV transmission system below. Transmission line impedances are:
Zl = 16.75L71° Ohm and Z2 = 13.4L71° Ohm. With a system impedance of 13.25L81 0 Ohm, the 3-phase fault current (amperes) at Station C is most nearly:



(A) 2,590
(B) 1,495
(C) 1,285
(D) 800

535. An electric generation facility uses a turbine-driven synchronous generator rated 3-phase, 150MVA,13.8kV. Per-unit (pu) reactances are *X"d* = 0.15; X *d* = 0.25; *Xd* = *Xq* = 1.20
Assume terminal voltage *(Et)*= 1.0 pu. For a simple transient study at rated MVA, rated voltage, and unity power factor, the internal voltage (pu) and reactance (pu) for the generator should be, respectively:
(A) 1.01 and 0.15
(B) 1.01 and 0.25
(C) 1.03 and 0.25
(D) 1.10 and 0.25

536. Consider a long 3-phase feeder with the following phase conductor properties:
Reactance, *XL* = 0.050 Ω, ac resistance, *R* = 0.050 Ω. The feeder is supplying a balanced load. For a fixed current of 50 A, which of the following statements concerning the phase-to-neutral voltage drop at the receiving end of the feeder is
most correct?
(A) The voltage drop is relatively independent of the load power factor.
(B) The voltage drop will be largest for a unity load power factor.
(C) The voltage drop will be largest for a zero load power factor.
(D) The voltage drop will be larger for a lagging load power factor of 0.707 than for either a unity load power factor or a zero load power factor.

14 – Waveforms

131. If a carrier wave of 10MHz is amplitude modulated by an audio signal of 1 kHz, the resultant signal to be broadcast contains only the:
(A) 10,001,000-Hz component
(B) 10,001,000-Hz and 9,999,000-Hz components
(C) 10,001,000-Hz, 10,000,000-Hz, and 9,999,000-Hz components
(D) 10,001,000-Hz, 10,000,000-Hz, 9,999,000-Hz, and 1,000-Hz components

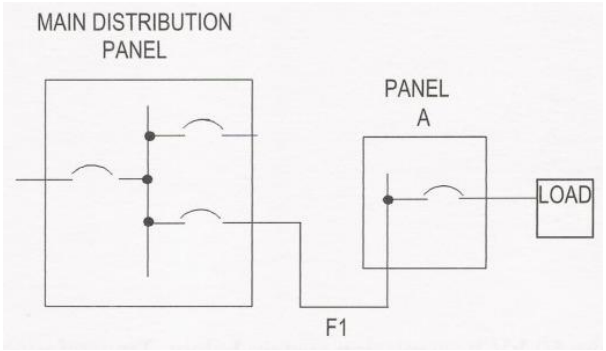
15 – Codes

504. The minimum size THWN copper conductors rated at 75°C installed in conduit required to serve a continuous duty 230-V 10-hp single-phase induction motor and non-continuous l-kW resistance heater on a circuit operating at 240-V single phase are:
(A) 4/0 AWG
(B) 2/0 AWG
(C) 4 AWG
(D) 6 AWG

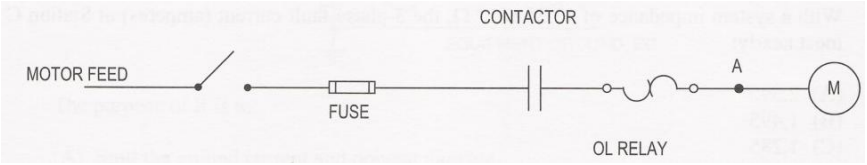
505. A squirrel-cage induction motor is rated 40 hp, 460 V, 3 phase, 60 Hz, 52 A, 0.87 lagging power factor at full load, Design E. The maximum locked-rotor current (amperes) for selection of the motor disconnect is most nearly:
(A) 412
(B) 356
(C) 300
(D) 240

506. You have sized branch-circuit conductors supplying a 3-phase squirrel-cage induction motor. Now you must size the fuses to protect those conductors against short circuit or ground faults. What is the correct approach?
(A) The maximum fuse rating is the ampacity of the conductors, except the next larger size fuses can be used if the conductor ampacity does not match a standard fuse size.
(B) The maximum fuse rating is 125% of the full-load current of the motor.
(C) The maximum fuse rating is 100% of the locked-rotor current of the motor.
(D) None of the above.

529. Assume the voltage at the main distribution panel is 480 V, 3-phase. Feeder Fl consists of three 500-kcmil THWN copper phase conductors and a neutral in a steel conduit that runs a distance of 250 feet. Panel A serves a constant, balanced load of 400 A at 0.80 lagging pf. The voltage (V) at Panel A is most nearly:
(A) 475
(B) 470
(C) 465
(D) 460



530. To correct power factor, a capacitor is proposed to be



connected to Point A in the 3-phase induction motor circuit shown in the figure below. Which of the following statements is most likely correct if the capacitor is added?
(A) The full-load current at Motor M will be significantly reduced.
(B) The motor overload relay trip settings should be reduced.
(C) The 2002 edition of the *National Electrical Code* requires that the capacitor be connected through a separate disconnect switch.
(D) The motor feed conductors may be sized for a reduced ampacity.

16 – Ethics

1. What is the difference in ethics and character?
2. Write a personal code of ethics. It should be approximately one paragraph. Short and succinct will keep you focused.
3. Describe a circumstance, that does not appear to be ethical, but it is not illegal.
4. Discuss some pros and cons of whistle blowing.
5. What is a positive ethical contribution that a professional can make when in another culture? It cannot have a negative impact on anyone in the society.
6. In some countries, contributions are a standard practice. Should you pay a percentage of a contract that is awarded? Why?