Answers to Review Questions

UNIT 1

5. 1 or 2
2. 7 or 8
3. silicon, germanium
4. A lattice structure is an ordered arrangement of atoms in the atomic structure of a material.
5. Add a material which has only 3 valence electrons to a pure semiconductor material.
6. Add a material which has 5 valence electrons to a pure semiconductor material.
7. Silicon
8. The thickness and manner in which the P- and N-type materials are joined together determine the components.
9. Composition carbon, metal film, carbon film, wire wound
10. Metal film resistors do not change their ohmic value with age.
11. Wire wound resistors have a higher power rating.
12. Yes (0.01 × 0.01 × 2000 = 0.2 watts)
13. No (24 × 24 / 350 = 1.645 watts)
14. 360,000, 5 percent
15. 10,500 and 9500 (10,000 × 0.05 = 500 Ω)
16. Yes
17. A variable resistor used to control voltage.

UNIT 2

1. 6
2. 62.5
3. 12.96
4. The heat sink increases the surface area of the component, which permits air to remove heat at a faster rate.
5. It produces a good thermal bond between two components.
6. 2 watts
7. 12 × 0.250 = 3 watts
8. 0.025 × 0.025 × 2700 = 1.6875 watts
9. No. 120 × 120 / 1000 = 14.4 watts
10. 0.7 × 16 = 11.2 watts

UNIT 3

1. Voltage
2. Time
3. Amplitude of voltage
4. 5000 Hz (1/0.000200)
5. 275 volts (approximately)

6. 30 volts peak, 6250 Hz
7. To show the position of the trace if it is off the display
8. The alternate mode alternates sweeps between channel 1 and channel 2. The cop mode alternates the sweep between the two channels several times during one sweep.
9. It will burn a spot on the face of the CRT.
10. It permits the oscilloscope to trigger on the positive or negative half of the waveform.
11. 5 MΩ (20,000 × 250)
12. 9600 Ω (20,000 × 12 = 240,000 Ω) (1/10,000 + 1/240,000 = 1/0.000104167)
13. Digital ohmmeter
14. 2.09 mA (4.6/2200)
15. Digital voltmeter

UNIT 4

1. 2
2. Silicon and germanium
3. 0.6 to 0.7
4. Positive
5. The amount of voltage it can hold off in the reverse direction.
6. The diode should show continuity through it when the positive lead of the ohmmeter is connected to the anode but not to the cathode.

UNIT 5

1. Light-emitting diode
2. DC
3. 1.7 volts
4. Light being emitted by the device
5. 2000 Ω
6. 0.45 volts
7. Arrows point away from the device when the symbol represents an LED. Arrows point toward the device when the symbol represents a photodiode.
8. The photodiode can operate at a greater speed.
9. In darkness
10. The light would be turned on during the daylight hours and off at night.

UNIT 6

1. A device that changes AC voltage into DC voltage.
2. The half-wave rectifier
3. The two-diode type of rectifier
4. The bridge rectifier
5. 8.1 volts (18/2 = 9, 9 × 0.9 = 8.1)
6. The two-diode type

7. 32.4 volts ($26 \times 0.9 = 32.4$)
8. The cathode ends

UNIT 7

1. Half wave
2. 6
3. Three-phase half-wave rectifier
4. 243.15 volts ($208 \times 1.169 = 243.15$)
5. 756 volts ($560 \times 1.35 = 756$)

UNIT 8

1. Single-phase half-wave rectifier
2. Three-phase bridge rectifier
3. A capacitor
4. An inductor or choke
5. Parallel with the load
6. Series with the load
7. It limits the current inrush when the power supply is first turned on.
8. 50.9 volts ($36 \times 1.414 = 50.9$)
9. Decrease
10. Increase
11. 5
12. A transformer that has its primary and secondary windings physically and electrically separated from each other.
13. Inductors and capacitors
14. Metal-oxide varistor or MOV
15. Joules

UNIT 9

1. A zener diode is designed to operate with current flow through it in the reverse direction and a junction diode is not.
2. It is destroyed.
3. Voltage regulator
4. 500 Ω ($7/0.014 = 500$)
5. Parallel
6. It causes a tunneling effect of charged current carriers through the depletion zone at the diode junction.
7. Reverse biased
8. Because they have only two states of operation, on or off.
9. Schottky diode
10. By controlling the amount of reverse voltage applied to the diode.
11. By separating two semiconductor regions with an intrinsic region.

12. By connecting it reverse biased
13. IMPATT

UNIT 10

1. 3
2. NPN and PNP
3. Silicon can withstand more heat.
4. The 2N registry
5. Anodes
6. The emitter lead
7. The collector lead
8. The amount of base–emitter current
9. The amount of collector–emitter current
10. Positive

UNIT 11

1. About 0.7 volts
2. About 0.3 volts
3. By supplying it with more base–emitter current than is needed to turn it completely on
4. The transistor can handle more current without overheating when it has a lower voltage drop.
5. It has a lower frequency response.

UNIT 12

1. To preset or precondition
2. Enough base current is permitted to flow through the transistor to turn it half on.
3. The transistor must be biased to permit it to reproduce both halves of the AC waveform.
4. 6 volts
5. 25 (25/0.5 = 50)

UNIT 13

1. By connecting the emitter of one transistor to the base of another transistor.
2. Beta
3. 6666.67 (0.100/0.000015 = 6666.67)
4. The transistor used to drive or furnish base current to the other transistor.
5. 300 μA (1.5/5000 = 0.000300)

UNIT 14

1. 20,000 MΩ
2. Junction field effect transistor
3. Positive

4. DE-MOSFET and E-MOSFET
5. MOSFET
6. E-MOSFET
7. JFET

UNIT 15

1. A circuit used to produce a certain amount of current as opposed to a certain amount of voltage.
2. The resistance is measured by passing a known amount of current through it and measuring the voltage drop.
3. The amount of current flow and the multiplication factor are changed.
4. 4–20 mA
5. It eliminates the problem of wire resistance.

UNIT 16

1. Thyristor
2. Emitter, base 1, and base 2
3. Base 1
4. By the RC time constant
5. Because it is produced by a discharging capacitor
6. Phase shifting an SCR
7. The operating voltage of the PUT can be set and the operating voltage of a UJT cannot.
8. Positive

UNIT 17

1. 4
2. Silicon-controlled rectifier
3. Anode, cathode, and gate
4. The gate current
5. The amount of current flow must drop below the holding current level before the SCR will turn off.
6. 2
7. The GTO can be turned off with a negative gate pulse and the SCR cannot.
8. 10 to 20 times

UNIT 18

1. DC
2. The AC waveform dropping back to 0 volt
3. The SCR can be controlled as to when it will turn on and permit current to flow through it.
4. 90 degrees
5. Earlier than 90 degrees

UNIT 19

1. Changing the phase of one thing in reference to another
2. The voltage applied to the gate and the voltage applied to the anode must be phase shifted.
3. A transformer
4. A capacitor
5. To gain complete control of the SCR

UNIT 20

1. For phase shifting SCRs
2. To provide low voltage for the UJT
3. DC
4. DC
5. Resistor R1
6. Because the pulses produced by the UJT are independent of the voltage applied to the anode of the SCR

UNIT 21

1. Single-phase bridge rectifier
2. They force the gates to share the current pulse delivered by the UJT.
3. A two-diode type of full-wave rectifier
4. Because both halves of the AC waveform must pass through one of the SCRs
5. Half-wave DC

UNIT 22

1. 120 volts AC
2. 12-volt battery
3. Double-pole, single-throw switch
4. Used as a pilot light to indicate that the power is turned on
5. Used to indicate that the alarm has been armed
6. A key-locked switch
7. Closed
8. It is used to kill the voltage spike produced by the coil of relay K1 when the power is turned off.

UNIT 23

1. To phase shift a triac
2. AC
3. Negative resistance
4. It is a bidirectional device.
5. It is a voltage-sensitive switch.

UNIT 24

1. AC
2. MT2
3. DC since the diode will permit only one-half of the triac to be fired
4. Either direction
5. They would be connected in parallel facing in opposite directions with their gate leads connected together.

UNIT 25

1. Separate the gate pulses from MT1 and MT2.
2. The diac
3. To gain complete control of the AC waveform applied to the triac.
4. The value of C1 and R2
5. It is used to limit current flow in the gate circuit of the triac if all the resistance should be adjusted out of resistor R2.

UNIT 26

1. It is connected in series with the load.
2. The bridge rectifier forces the current to flow through an SCR or transistor in only one direction.
3. The triac sometimes fires on one-half of the AC waveform before the other. This causes a DC voltage to be applied to the load.
4. The current flow through an inductive load is limited mostly by inductive reactance. When a DC voltage is applied, the current flow is limited only by the amount of wire resistance.
5. The transistor controls the output voltage by varying the amplitude of the waveform and not by chopping it as the SCR does.

UNIT 27

1. A triac
2. A power transistor
3. The load side of the relay is optically isolated from the control side.
4. Optoisolation and reed relay
5. No, it connects the load to the line in the same manner as a magnetic relay.

UNIT 28

1. A device used to convert DC into AC.
2. At a lower frequency the inductive reactance of the stator winding is less. Voltage must be reduced to prevent excessive current from flowing in the stator.
3. It more closely approximates a sine wave.
4. Square wave
5. The turns of wire on the transformer and the applied voltage

UNIT 29

1. It must be converted to alternating current.
2. A two-diode type of full-wave rectifier
3. Square wave AC
4. It is used to filter the DC voltage.

UNIT 30

1. They change immediately.
2. They delay changing back.
3. The resistance of the coil and the capacitance of C1
4. Delay on de-energize
5. It is used to prevent a voltage spike from being induced into the circuit by coil K1 when the power is turned off.
6. It permits capacitor Ct to be charged immediately when switch S1 is closed.

UNIT 31

1. They delay changing position.
2. They return to their normal position immediately.
3. The resistance of Rt and the capacitance of C1
4. It is used to produce a spike voltage when the UJT turns on and discharges capacitor C1.
5. Switch S1 must be opened.

UNIT 32

1. An on-delay timer turns on and stays on until it is turned off. The pulse timer turns on and then turns itself off again after some amount of time.
2. It is used to provide the pulse needed to turn on the relay.
3. It adjusts the amount of time between the pulses and then turns the relay on.
4. It adjusts the amount of time the relay remains turned on before it turns back off again.
5. A transistor used to steal the base current from some other transistor and therefore keep it turned off.

UNIT 33

1. Pin #1
2. Less than one-third of Vcc
3. 3 to 16 volts
4. No
5. It activates the discharge and keeps the timer from operating.
6. The trigger is used to turn the discharge off.
7. On

UNIT 34

1. It permits the timer to retrigger when voltage applied to pin #6 drops below one-third of Vcc.
2. The on time is determined by the capacitance of C1 and the combined resistance of R1 and R2.
3. The off time is determined by the capacitance of C1 and the resistance of R2.
4. It causes the timer to remain on longer.
5. It causes the timer to remain on for a shorter period of time.
6. Pin #5 does not affect the off time of the timer.

UNIT 35

1. It is used to connect the relay coil to the line.
2. It is a kickback diode used to kill any spike voltages produced by coil K1 when the power is turned off.
3. It is a stealer transistor used to keep transistor Q1 turned off when pin #3 of the 555 timer is turned on.
4. It is used as a latch to keep the timer turned off after relay K1 has been turned on.
5. It is used as a short time delay for transistor Q1.
6. The values of capacitor C1 and resistors R1 and R2

UNIT 36

1. It is used to keep capacitor C1 from discharging through resistors R2 and R1.
2. The reset pin must be connected to a voltage that is greater than two-thirds of Vcc in order for the timer to operate.
3. The values of capacitor C1 and resistor R2
4. The values of capacitor C1 and resistors R3 and R4
5. It limits the amount of base current to transistor Q1.

UNIT 37

1. A power supply which has both a positive voltage as compared to ground and a negative voltage as compared to ground.
2. A center-tapped transformer
3. Aboveground
3. 1. Two bridge rectifiers can be used by connecting the positive output of one rectifier to the negative output of the other. This connection becomes circuit ground.
   2. The secondaries of the two transformers can be connected series aiding. The junction of the two secondaries becomes the center tap. A bridge rectifier is then used to provide above- and belowground voltages.
4. The positive terminal

UNIT 38

1. It permits the op amp to have high input impedance.
2. 2 MΩ
3. With a negative feedback loop

4. It reduces the gain and makes the amplifier more stable.
5. R1 + R2/R1 = 750 + 15,000/750 = 15,750/750 = 21
6. R2/R1 = 100,000/1200 = 83.3

UNIT 39

1. Low
2. About +2.5 volts
3. It permits adjustment of the level at which the amplifier changes the state of the output voltage.
4. High
5. No. The 15-volt output of the op amp can never overcome the breakdown voltage of the zener diode.

UNIT 40

1. Yes
2. Noninverting input
3. Voltage divider
4. T = 2RC, T = 2 × 4700 × 0.0000001, T = 0.00094
   F = 1/T, F = 1/0.00094, F = 1063.8 Hz
5. An oscillator produces positive and negative pulses which last the same length of time. A pulse generator's pulses are generally not the same length of time.

UNIT 41

1. Because of internal impedance of the power supply
2. It means that the impedance changes.
3. It means that the regulator is connected in series with the load.
4. It means that the regulator is connected in parallel with the load.
5. It must have resistance connected in series with the load and regulator.
6. The gain of the circuit
7. By sensing the voltage drop across a low value of resistance connected in series with the load.

UNIT 42

1. 405^{10} (convert lights to binary number) (110010101) (changed to decimal number)
   (256 + 128 + 16 + 4 + 1 = 405)
2. 131^{8} (89/8 = 11 with a remainder of 1) (11/8 = 1 with a remainder of 3) (1/8 = 0 with a remainder of 1)
3. D3F^{16} (Divide the binary number into groups of 4 digits.) (1101 0011 1111) (Convert the binary numbers to equivalent hexadecimal numbers.)
4. 111100010^{2} (Change the octal number to the equivalent binary number using groups of 3 binary digits.)
   (7 = 111, 4 = 100, 2 = 010)
5. Binary (1101100101^{2}) (869/2 = 434r1) (434/2 = 217r0) (217/2 = 108r1) (108/2 = 54r0) (54/2 = 27r0) (27/2 = 13r1) (13/2 = 6r1) (6/2 = 3r0) (3/2 = 1r1) (1/2 = 0r1)
   Octal (1545^{8}) (869/8 = 108r5) (108/8 = 13r4) (13/8 = 1r5) (1/8 = 0r1)
   Hexadecimal (365^{16}) (869/16 = 54r5) (54/16 = 3r6) (3/16 = 0r3)

6. 5076^8 (Convert $A3E_{16}$ to decimal.) ($A3E_{16} = 2622_{10}$) (Convert 2622_{10} to octal.)
7. $F_3^{16} = 243^{10}$ (F = 15) ($15 \times 16 = 240$) ($3 \times 1 = 3$) ($240 + 3 = 243$)
8. 1551^{10} (Convert lights into binary number in groups of 3.) (101 = 5, 100 = 4, 001 = 1, 111 = 7) (Octal number is 5417^8.) (Convert octal number to decimal.) ($7 \times 1 = 7$) ($1 \times 8 = 8$) ($64 \times 4 = 256$) ($512 \times 5 = 2560$) ($2560 + 256 + 8 + 7 = 2831^{10}$)
9. $B0F^{16}$ (Group binary numbers into groups of 4.) (1011 = B, 0000 = 0, 1111 = F)
10. 2831^{10} (Convert B0F to decimal.) (B = 11) ($11 \times 256 = 2816$) (F = 15) ($15 \times 1 = 15$) ($2816 + 15 = 2831$)

UNIT 43

1. Resistor transistor logic, diode transistor logic, and transistor transistor logic
2. CMOS
3. All inputs must be high.
4. Any high input will produce a high output.
5. Any low input will produce a high output.
6. All inputs must be low to produce a high output.
7. A device which has only two states, high or low
8. In relay logic, there is one input and multiple outputs. In gate logic, there are multiple inputs and one output.
9. Either, but not both, of the inputs must be high to produce a high output.
10. It means to invert the output.

UNIT 44

1. To ensure good contact when the switch operates.
2. Because relay circuits are slow acting and computer circuits are fast acting.
3. Inverting

UNIT 45

1. A solar cell produces a voltage in the presence of light. A cad cell exhibits a change of resistance in the presence or absence of light.
2. 0.5 volt
3. About 50 Ω
4. It permits the cad cell to operate as a digital device.
5. The cad cell was connected to the noninverting input instead of the inverting input.

UNIT 46

1. It is used to adjust the light sensitivity of the circuit.
2. It is used to produce an inverted output from that of the operational amplifier.
3. It is a kick back diode used to kill the induced voltage spike produced by coil CR.
4. The capacitance of capacitor C5 and the combined resistance of resistors R10 and R11
5. It permits the trigger of timer "A" to receive a low pulse.

UNIT 47

1. A set of contacts connected in parallel with the start button
2. The overload heater
3. A feedback is connected from the output of the AND gate to the input of the OR gate.
4. Because it can have an indeterminate state
5. Because they have a drop in output voltage when taken low through a resistor

UNIT 48

1. It resets to lock so that the combination must be started over.
2. High
3. It indicates when the output of the lock is high or low.
4. It limits the amount of current flow through the LED.
5. The bounceless switch circuit

UNIT 49

1. When a constant current is passed through a pn junction, its voltage drop is proportional to temperature.
2. Decrease
3. Linear
4. Change the connections of the inverting and noninverting inputs.
5. DPDT Switch