1-11 When a **free electron moves away from its donor atom**, it leaves behind a **positively charged ion.**

-TRUE

2-11 **Phosphorus (P) and Arsenic (As)** are commonly used as **donor atoms** in silicon.

-TRUE

3-11 **Phosphorus (P) and Arsenic (As)** are commonly used as **acceptor atoms** in silicon.

-FALSE

6-12 **Boron (B)** is commonly used as a **donor atom** in silicon.

-FALSE

3-12 **Silicon** has approximately **5.0 x 10^22 atoms/cm^3.**

-TRUE

1-12 A **hole** is really just the absence of an electron, and can be thought of as a **positively charged** particle.

-TRUE

2-12 A **hole** is really just the absence of an electron, and can be thought of as a **negatively charged** particle.

-FALSE

4-11 When a **hole moves away** from it’s acceptor atom, it **leaves behind a positively charged ion.**

-FALSE

1-12 In a **semiconductor doped with acceptor atoms**, the **number of holes is much higher than the number of electrons.**

-TRUE

6-11 In a **semiconductor doped with acceptor atoms**, the **number of electrons is much higher than the number of holes.**

-FALSE

1-11 In a **semiconductor doped with donor atoms**, the **number of holes is much higher than the number of electrons.**

-FALSE

3-11 Both **electrons and holes** are charge carriers which **can move around and conduct electricity.**

-TRUE

1-12 Both **holes and electrons** leave **behind immobile ions when they conduct electricity**.

-TRUE

3-13 When the **donor and acceptor atoms** near a PN junction **are ionized**, the **ionized atoms move away from the junction.**

-FALSE

1-13 For **linearly graded PN junctions**, the depletion capacitance depends on the square root of the reverse bias voltage.

- FALSE1-14 For **abrupt step PN junctions**, the depletion capacitance depends on the **cube root** of the reverse bias voltage.

-FALSE

4-13 For **abrupt step PN junctions**, the depletion capacitance depends on the **square root** of the reverse bias voltage.

-TRUE

6-13 When **p-type silicon** is brought into **contact with metal,** a **PN junction is formed**.

-FALSE

1-14 The **p-side of a PN junction is called the cathode**, and the **n-side of the PN junction is called the anode.**

-FALSE

6-14 The **separation of charge caused by the immobile ions** in the depletion region surrounding a PN junction **causes the “built-in voltage”,** which assists the further diffusion of electrons and holes.

-FALSE

7-14 The **separation of charge caused by the immobile ions** in the depletion region surrounding a PN junction **creates an electric field**, which assists the further diffusion of electrons and holes.

-FALSE  
1-15 Using a **larger filter capacitor** in a power supply will result in both l**ower ripple and lower cost.**

- FALSE --Larger capacitors reduce **ripple more, but also cost more.**

1-16 The **Peak Inverse Voltage** required for the diodes in a **bridge rectifier** **is only about half of that required for a full wave rectifier which uses a center-tapped transformer.**

**-**TRUE

8-17 The **Peak Inverse Voltage** required for the diodes in a **full wave rectifier** **which uses a center-tapped transformer is only about half of that required for a bridge rectifier**.

- FALSE

5-16 **Clamped Capacitor** circuits can be used to restore DC values to AC coupled signals.

-TRUE

4-18 The **output voltage for a bridge rectifier** is just slightly **higher** than the output voltage for a **full wave rectifier** which uses a **center-tapped transformer**

-FALSE

4-15 The **output voltage for a bridge rectifier** is just slightly **lower** than the output voltage for a **full wave rectifier** which uses a **center-tapped transformer**

* TRUE

1-16 If the **reverse bias voltage** applied across a diode **gets too high and exceeds the breakdown voltage** for the diode, then the **reverse current flowing through the diode will increase sharply.**

-TRUE

1-17 **Peak Detectors** are often used to **create** an output voltage which is equal to the **maximum value of an input signal.**

-TRUE

4-16 **Peak Detectors** are often used to **charge up a capacitor** to the **maximum value of an input signal.**

-TRUE

3-17 **Diodes** can be used to **limit how low the magnitude of a signal can go**.

-FALSE

1-18 The size of the **ripple voltage** at the output of a power supply filter capacitor is **inversely** proportional to the **period of the input sine wave**.

-FALSE

2-18 The size of the **ripple voltage** at the output of a power supply filter capacitor is **directly** proportional to the **period of the input sine wave.**

-TRUE

4-17 The **size of the ripple voltage** at the output of a power supply filter capacitor is **directly** proportional to the **size of the current supplied to the load.**

-TRUE

4-18 **The size of the ripple voltage** at the output of a power supply filter capacitor is **inversely** proportional to the **frequency of the input sine wave**.

-TRUE

1-19 The **threshold voltage of a MOSFET** is the amount of voltage that must be applied between the gate and the source in order for a channel to be formed between the drain and the source.

-TRUE

3-19 The **threshold voltage** for a **PMOS FET is negative**.

-TRUE

2-19 The **capacitance of a MOSFET’s** gate **increases as the thickness of the gate oxide increases.**

- FALSE

4-19 The **length of the channel in a MOSFET** is the **distance between the drain and the source.**

-TRUE

4-11 When **silicon is doped with donor atoms**, this **increases the number of electrons**

-TRUE **(**4-12 **5-12)**

4-12 When **silicon is doped with acceptor atoms**, this **increases the number of electrons.**

-FALSE (4-11)

5-12 When **silicon is doped with acceptor atoms**, this **increases the number of holes**

-TRUE **(**4-12 , 4-11**)**

2-13 As the **forward bias** across a PN junction is **decreased**, the **potential barrier decreases**.

-FALSE

7-14 As the **forward bias** across a PN junction is **increased**, the **potential barrier increases**.

-**FALSE**

4-13 As the **reverse bias** across a PN junction is **decreased**, the **width of the depletion region decreases**

-TRUE

5-14 As the **reverse bias** across a PN junction is **increased**, the **width of the depletion region increases.**

-TRUE

4-14 As the **reverse bias** across a PN junction is **increased**, the **potential barrier decreases.**

-FALSE

6-13 As the **reverse bias** across a PN junction is **increased**, the potential barrier **increases**.

-TRUE

5-13 The **charge stored in the depletion region** increases as the reverse bias voltage increases, which causes a capacitance.

-TRUE

8-13 The charge stored in the depletion region decreases as the reverse bias voltage increases, which causes a capacitance.

* FALSE

9-20 The resistance of a MOSFET operating in triode decreases as |Vgs| - |Vt| increases.  
 - TRUE

4-13 The **Zener effect** typically causes the reverse breakdown of PN junctions **which break down at voltages < 5V.**

-TRUE

4-14 **Lightly doped** PN junctions **break down at higher** reverse voltages than heavily doped PN junctions

-TRUE

5-14 **Lightly doped** PN junctions **break down at lower** reverse voltages than heavily doped PN junctions.

-FALSE

8-14 **Heavily doped PN junctions** break down at lower reverse voltages than lightly doped PN junctions.

-TRUE

4-14 The **minimum value** for the **depletion region capacitance of a reverse biased** PN junction occurs when the r**everse bias is equal to zero volts**.

-FALSE

4-15 The **incremental resistance for a Zener diode** is the **reciprocal of the slope** of the diode’s I-V characteristic curve as the reverse voltage across the diode increases above the diode’s reverse breakdown voltage.

-TRUE

4-15 The **incremental resistance for a Zener diode** is the **slope of the diode’s I-V characteristic** curve as the reverse voltage across the diode increases above the diode’s reverse breakdown voltage.

-FALSE

5-16 The **incremental resistance for a Zener diode** is used to **model how much the voltage across the forward biased diode increases as the forward current flowing through it increases**.

-False

5-15 Once a **Zener diode breaks down** in the reverse direction, the voltage across it only changes slightly as the current through it varies.

-TRUE

4-16 For a **Full Wave Rectifier** the **diodes** must be able **to handle a Peak Inverse Voltage equal to nearly TWICE the peak of the input voltage.**

-TRUE

4-17 In a **full-wave rectifier** the **diodes turn on twice** during **each period of the input sine wave to recharge the filter capacitor.**

-TRUE

4-17 The **Exponential diode model** provides the **best accuracy when analyzing diode circuits, but requires an iterative numerical approach to solve the nonlinear equations involved.**

-TRUE

5-17 The **Exponential diode model** provides a **good compromise between accuracy and ease of use when analyzing diode circuits.**

-FALSE

5-16 To **solve a nonlinear circuit equation by iteration**, you should **use logarithms instead of exponentials to aid in convergence.**

-TRUE

4-19 **NMOS FETs** use **N+ doped source** and **drain diffusions in a P-type substrate**.

-TRUE

5-19 **PMOS FETs** use **P+ doped source** and **drain diffusions in a P-type substrate**.

- FALSE

4-20 The **saturation region of operation for a MOSFET** is when |Vgs| > |Vt| so that the FET is turned on, and |Vds| < |Vgs| - |Vt| so that the channel **is pinched off near the drain**

-FALSE

3-20 The **triode region of operation for a MOSFET** is when |Vgs| > |Vt| so that the FET is turned on, and |Vds| > |Vgs| - |Vt| so that the channel **connects the drain and the source**.

-FALSE

5-15 **Linear circuit analysis** techniques can be **applied to nonlinear circuits as long as the variations around the bias point are kept small enough.**

-TRUE

5-16 When **performing a Load Line analysis** on a diode circuit to find the bias point, the operating point for the diode is where the linear equation for the circuit and the diode’s nonlinear I-V characteristic curve both cross the X-axis on the plot.

-FALSE

5-16 The simplest model to use when analyzing diode circuits is the Ideal Diode model, which assumes that the diode is a 0.7V battery when forward biased and an open circuit when reverse biased.

-FALSE

2-16 When a small reverse bias voltage is applied across a diode, the diode only conducts a small forward current called the saturation current.

-FALSE

2-11 **Intrinsic** semiconductors have controlled amounts of impurity atoms added to vary their resistance.

-False: **Semiconductors are doped with impurity atoms but intrinsic Semiconductors are pure without doping.**

2-12 The **intrinsic carrier** concentration for silicon is about **1.5 x 10^10/cm^3 at** room temperature (300°K).

-TRUE

2-13 The reverse breakdown voltage of a PN junction **increases** as the doping levels increase.

-FALSE: The reverse breakdown voltage(Vz) drops as doping levels increase.

2-14 The “built-in voltage” for a PN junction goes down as the doping levels increase.

-FALSE: Higher NA, ND -> Higher V0

2-15 When a forward bias voltage is applied across a diode, the diode current will increase exponentially as the voltage across the diode increases linearly.

-TRUE

3-15 A **large enough piece of anything nonlinear looks linear**.

-FALSE

5-15 A **small enough piece** of anything **nonlinear looks linear**.

-TRUE

2-16 The **filter capacitor must be twice as large** in a **full-wave rectifier than in a half-wave rectifier to obtain the same ripple voltage.**

-FALSE

3-16 In the **small-signal** equivalent for a circuit containing a reverse biased Zener diode, the diode is replaced by it’s small-signal model which is a DC battery.

-FALSE

4-17 In the **small-signal** equivalent for a circuit containing a forward biased diode, the diode is replaced by it’s small-signal resistance which is proportional to the operating temperature.

-TRUE

2-16 (2-18) A **Half Wave** Rectifier allows both the positive and negative peaks of the input sine wave through to the output.

-FALSE: Full wave

2-17 In a **power supply a large filter capacitor** is typically used to smooth out the pulses from the rectifier to create a nearly constant output voltage, **with only small variations called ripple**.

-TRUE

3-18 In a **power supply a large filter capacitor** is typically used to smooth out the pulses from the rectifier to create a constant output voltage **which doesn’t vary over time**.

-FALSE

2-17 In a **power supply diodes** are typically used to rectify the AC input voltage, which means converting a unipolar sine wave into a series of bipolar pulses.

-FALSE

2-17 The **voltage across a forward biased silicon diode** will change by about +2mV/°C as temperature changes.

-FALSE

2-18 In a **power supply a transformer** is typically used to **reduce the high line voltage** to a more useful, **lower value**.

-TRUE

2-18 In a **power supply a transformer** is typically used to **increase the low line voltage** to a more useful, **lower value**.

-FALSE

8-18 In a **power supply a transformer** is typically used to **increase the low line voltage** to a more useful, **higher value**.

-FALSE

2-18 (2-16) A **Full Wave** Rectifier allows only the positive or negative peaks of the input sine wave through to the output, but not both.

-FALSE: **Half wave**

2-19 When **FETs are built, parasitic PN junction** diodes are also created that must be kept reverse biased at all times.

-TRUE

2-20 The **slope of the Id versus Vds curve** for a **MOSFET** in saturation is very small.

-TRUE

2-20 The **Id versus Vds curve for a MOSFET** is linear even for large values of |Vds|, as long as |Vds| < |Vds-sat|.

-FALSE

3-11 **Silicon is the most widely** used **semiconductor today**.

-TRUE

3-12 At room temperature (300°K) there is **enough thermal energy** to **break some bonds and create electron-hole pairs**

-TRUE

3-13 The **diffusion capacitance** for a PN junction is **directly** proportional to the **average time** it takes for a carrier to recombine after it crosses the junction.

-TRUE

3-13 The **diffusion capacitance** for a PN junction is **inversely** proportional to the **average time** it takes for a carrier to recombine after it crosses the junction.

-FALSE

3-13 The **diffusion capacitance** for a PN junction is **directly** proportional to **temperature**.

-FALSE

3-14 The **diffusion capacitance** for a PN junction is **inversely** proportional to **temperature**.

-TRUE

3-14 The **diffusion capacitance** for a PN junction **models the variations** in the excess charge stored as **carriers are injected across the junction with variations in the reverse bias voltage applied.**

-FALSE

2-15 The **output voltage of a Voltage Doubler** circuit is about **twice the peak value of the input voltage.**

-TRUE

3-17 The **output voltage of a Voltage Doubler** circuit is about **twice the DC value of the input voltage.**

-FALSE

3-15 Diode limiters are used to control the gain of a circuit after the diodes turn on.

-TRUE

3-15 The **final stage in** a power supply **is a voltage regulator**, which keeps the **output voltage constant as both the input voltage and the load current vary.**

-TRUE

3-16 The **peak current** **which flows** in the rectifier diodes for a power supply **is often much larger than the current supplied to the load.**

-TRUE

4-18 The **peak current which flows** in the rectifier diodes for a power supply **is often much smaller than the current supplied to the load.**

-FALSE

3-16 The **average current which flows** in the rectifier diodes for a power supply **is typically about twice the peak current which flows in these same rectifier diodes.**

-FALSE (1-16)

2-16 The **peak current** **which flows** in the rectifier diodes for a power supply **is typically about twice the average current which flows in these same rectifier diodes.**

-TRUE

3-17 The **RC time constant** for the filter capacitor in a power supply is typically **set so large** that the **capacitor discharge appears exponential**.

-FALSE

3-18 The **RC time constant** for the filter capacitor in a power supply is typically **set much larger** **than the period of the input sine wave**.

-TRUE

3-18 **One of the most useful applications** for diodes is in DC power supplies, which **convert an AC input voltage into a DC output voltage.**

-TRUE

3-16 **One of the most useful applications** for diodes is in DC power supplies, which **convert a DC input voltage into an AC output voltage.**

-FALSE

3-19 When **|Vgs| < |Vt| for a MOSFET** the gate **forms a parallel-plate capacitor between the gate and the channel.**

-FALSE

3-20 For a **MOSFET operating in triode**, the c**hannel extends all the way from the source to the drain.**

-TRUE

2-20 For a **MOSFET operating in saturation**, the **channel is pinched off near the drain.**

-TRUE

3-20 A **MOSFET** enters the **saturation region** of operation when the **gate-to-channel voltage at the drain end of the channel rises above the threshold voltage**.

-FALSE

4-20 The **cutoff region of operation for a MOSFET** is when |Vgs| < |Vt| so that the FET is turned off and no channel exists.

-TRUE

5-20 For a **MOSFET** with **Vds > 0,** the gate-to-channel voltage is **higher** at the drain end of the channel than at the source end.

-FALSE

6-20 5-20 For a **MOSFET** with **Vds > 0,** the gate-to-channel voltage is **lower** at the drain end of the channel than at the source end.

-TRUE

7-20 The **resistance of a MOSFET operating in triode** decreases as the W/L of the MOSFET increases.

-TRUE

5-13 The Avalanche effect typically causes the reverse breakdown of PN junctions which break down at voltages < 5V.

-FALSE

1-20 For a MOSFET in saturation, the amount of charge in the channel at the drain end is approximately zero.

-TRUE

3-19 The amount of charge stored on a MOSFET’s gate capacitance is directly proportional to |Vgs| – |Vt|.

-TRUE

4-19 The process transconductance for a MOSFET, k’ , is directly proportional to the gate oxide capacitance, the carrier mobility, and the W/L of the FET.

-FALSE

4-19 Modern CMOS processes use an N-type silicon substrate with NMOS FETs built in P-wells.

-FALSE

7-11 Intrinsic semiconductors are pure, without any impurity atoms added.

-**TRUE**

7-16 When a small reverse bias voltage is applied across a diode, the diode only conducts a small reverse current called the saturation current.

-**TRUE**

7-17 The size of the ripple voltage at the output of a power supply filter capacitor is inversely proportional to the size of the filter capacitor used.

-**TRUE**

7-18 Using a larger filter capacitor in a power supply will result in lower ripple, but cost more.

-**TRUE**

7-19 Key parameters which circuit designers use to control how a MOSFET operates is the width and length of the source.

-**FALSE**

7-20 A MOSFET enters the saturation region of operation when the gate-to-channel voltage at the drain end of the channel drops below the threshold voltage.

-**TRUE**

5-14 As the reverse bias across a PN junction is increased, the width of the depletion region increases.

-TRUE

5-15 Linear circuit analysis techniques can be applied to nonlinear circuits as long as the variations around the bias point are kept small enough.

-TRUE

5-16 The simplest model to use when analyzing diode circuits is the Ideal Diode model, which assumes that the diode is a 0.7V battery when forward biased and an open circuit when reverse biased.

-FALSE

5-17 When a forward bias current flows through a diode, the voltage across the diode will increase logarithmically as the current through the diode increases linearly.

-TRUE

5-18 A Half Wave Rectifier allows only the positive or negative peaks of the input sine wave through to the output, but not both.

-TRUE

5-19 The capacitance of a MOSFET’s gate decreases as the thickness of the gate oxide decreases.

-FALSE

5-20 For |Vgs| < |Vt| the drain current for a MOSFET actually drops exponentially as |Vgs| is decreased rather than just suddenly going to zero.

-TRUE

8-12 In a semiconductor the number of holes multiplied by the number of electrons is equal to a constant except when dopant atoms are added.

-FALSE

8-15 Diode limiters can be used to make a square wave look more like a sine wave, which is useful in communications circuits

-FALSE

8-19 For a MOSFET in saturation, changes in Vds have only a small effect on the drain current because the channel is pinched off at the drain end.  
 - TRUE

9-13 Diffusion refers to the fundamental property in nature that most things tend to move from areas where they are in high concentration to areas where they are in low concentration

* TRUE

9-14 The depletion region capacitance decreases nonlinearly as the reverse bias voltage is increased

* TRUE

9-17 A **Voltage Doubler circuit** can be built by combining a **clamped capacitor** circuit with a **DC restorer circuit**

* FALSE -- **combining a clamped capacitor circuit and a peak detector circuit, we can build a voltage doubler**

9-19 The threshold voltage for an NMOS FET is negative

* FALSE