NKRUMAH UNIVERSITY OF SCIENCE AND T

COLLEGE OF SCIENCE

FACULTY OF PHYSICAL AND COMPUTATIO

DEPARTMENT OF PHYSICS

Sc Physics/B.Sc Met. & Cli. Science/B.Sc C

End of First Semester Examinatio

SECOND YEAR

251 INTRODUCTORY ELECTRONICS/PHY

1. Which of the following statements is false?
   a). When atoms are packed closely together to form a crystal, the allowable energy levels broaden into bands of energy.
   b). Between adjacent energy bands are gaps or forbidden regions where there are no allowable energy levels
   c). The presence of electrons in the conduction band is crucial to the conduction process.
   d). At 0 K, the electrons in the valence band are free to move under an applied electric field

2. Suppose that we add some arsenic atoms to Germanium, which of the following statements is false:
   a). The crystal structure will remain unchanged
   b). The electronic structure will change
   c). One electron that can affect conductivity has been added per replacement atom.
   d). The crystal structure will change

3. Consider the following statement – electrons from the valence band are easily promoted to the acceptor level leaving behind holes that are very effective in carrying charge.- Which type of semiconductor is the above statement referring to?
   a). P-type semiconductor
   b). N-type semiconductor
   c). P-N junction
   d). None of the above

4. During the formation of a P-N junction the n side of the junction contains a net positive charge. Similarly in the p material, there will be a region close to the junction that is depleted of holes and contains a net negative charge. These charges are due to :
   a). The diffusion current
   b). The drift current
   c). bound charges associated with donor and acceptor atoms
   d). doping in the semiconductor

5. Which of the following statements about an intrinsic semiconductor is false?
   a). In a pure or intrinsic semiconductor, there are equal numbers of electrons and holes and these are thermally generated.
   b). When an electric field is applied they move in opposite directions with the holes drifting opposite to the direction of the field
   c). The mobility of an electron, its average velocity per unit electric field intensity is usually much greater than that of a hole.
   d). At sufficiently low temperatures (0 K) all covalent bonds are intact and no free electrons are available to conduct electric current

6. Which of the following statements is false for a P-type semiconductor?
   a). It is positively charged
   b). It is electrically neutral
   c). Majority charge carriers are holes and minority carriers are electrons
   d). It is formed by a trivalent impurity

7.

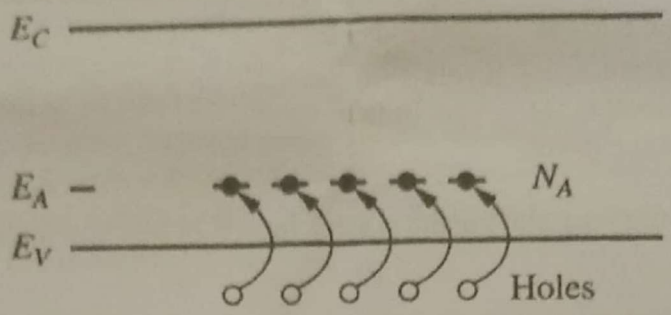


Figure 1

The diagram in figure 1 shows the energy band model for a p-type doped semiconductor. Which of the following statements is false?

a) At 0 K an electron participating in a covalent bond is in a lower energy state in the valence band.
b) The acceptor atoms have unfilled covalent bonds with energy state E_A.
c) Movement of electrons to acceptor sites, complete covalent bond pairs, and create holes.
d) Movement of electrons to acceptor sites, break covalent bond pairs, and create holes.

8. The energy gap represented by E_f in figure 1 has the value
   a). 0.01 eV
   b). 0.001eV
   c). 0.025 eV
   d). 0.0025 eV

9. A semiconductor material has a _____ temperature coefficient of resistance, which means that as temperature increases its resistance _____

   a) Positive, increase
   b) Positive, decrease
   c) Negative, increase
   d) Negative, decrease

10. Intrinsic semiconductors are doped to increase their _____
   a) Resistance
   b) Conductance
   c) Inductance
   d) Reactance

11. The basic function of a semiconductor device in an electrical or electronic circuit is to:
   a) Control current
   b) Control voltage
   c) Increase the price of the equipment
   d) Both (a) and (b) are true

12. Under open circuit conditions, the movement of charge carriers in a semiconductor as a result of differences in concentration gives rise to a current called

a). Diffusion current
b). Drift current
c). Drift velocity
d). Saturation current

13. Which of the following statements is false for a P-N junction under open circuit conditions?

a). The direction of the drift current is from the N to the P-side.
b). The drift current is a strong function of temperature
c). The drift current is independent of the value of the depletion layer voltage
d). None of the above

14. Which of the following is false? For a reverse biased P-N junction

A. The electric field within the junction increases

B. The barrier potential increases

C. The only contribution to current flow are thermally generated minority carriers

D. The width of the space charged region decreases

15. Zener breakdown occurs when

a. The electric field in the depletion layer increases to the point where it can break covalent bonds and generate electron-hole pairs
b. The minority carriers that cross the depletion region under the influence of the electric field gain sufficient kinetic energy to be able to break bonds and generate electron hole pairs.
c. When the voltage drop across a fully conducting diode exceeds 0.7 V
d. Non of the above

16 Avalanche breakdown occurs when

a. The electric field in the depletion layer increases to the point where it can break covalent bonds and generate electron-hole pairs
b. The minority carriers that cross the depletion region under the influence of the electric field gain sufficient kinetic energy to be able to break bonds and generate electron hole pairs.
c. When the voltage drop across a fully conducting diode exceeds 0.7 V
d. None of the above.

17. The unidirectional-current-flow property makes the diode useful in the design of

a. P-n junction diodes
b. Diode valves
c. Rectifier circuits
d. Semiconductor diodes

18. Which of the following statements is not a characteristic of an ideal diode?
    a). If a positive current is applied to the diode, a zero voltage drop appears across the diode.
    b). If a negative voltage is applied to the diode, no current flows and the diode behaves as an open circuit.
    c). The breakdown region is entered when the magnitude of the reverse current exceeds a threshold value specific to the particular diode, called the breakdown voltage.
    d). None of the above

19. In the forward direction, the ideal diode conducts any current forced by the external circuit while displaying a
    a. Zero voltage drop
    b. Negative voltage drop
    c. Positive voltage drop
    d. A 0.7 V voltage drop

20. If the p-type end of a silicon diode is at a voltage of 3 V and the n-type end is at 0 V
    a. the diode is not biased properly
    b. the diode is forward biased and current flows
    c. the diode is reverse biased and no current flows
    d. the diode is forward biased but current does not flow

21. In the figure 2, below, identify the forward-biased diode(s)

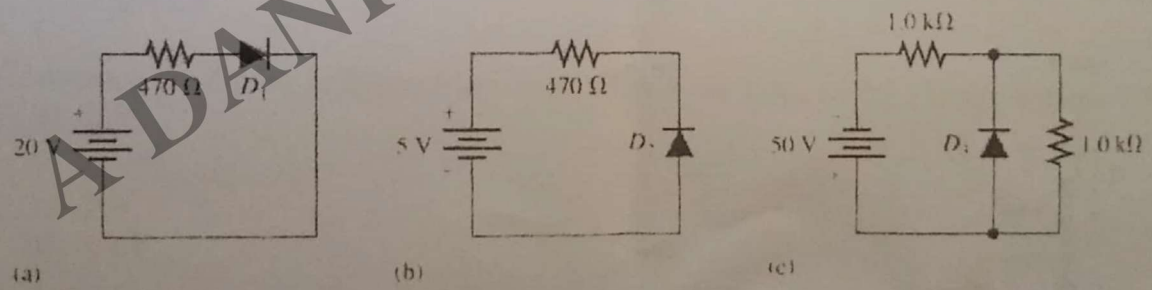


Figure 2

    a) D_1
    b) D_2
    c) D_3
    d) D_1 and D_3

22. When the positive lead of an analog ohmmeter is connected to the cathode of a diode and the negative lead is connected to the anode, the meter reads
    a) a very low resistance
    b) an extremely high resistance or open
    c) a high resistance initially, decreasing to about 100 Ω
    d) a gradually increasing resistance

23.Using Thevenim’s equivalent circuit model, determine the voltage at node B, in figure 3

a) 0 V
b) 10 V
c) 20 V
d) -20 V

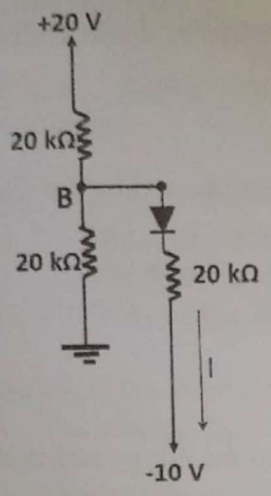


FIGURE 3

24. Assume the diode in figure 3 is ideal, determine the value of the current I

a) 0.5 A
b) 0.5 mA
c) 1.0 mA
d) 1.5 A

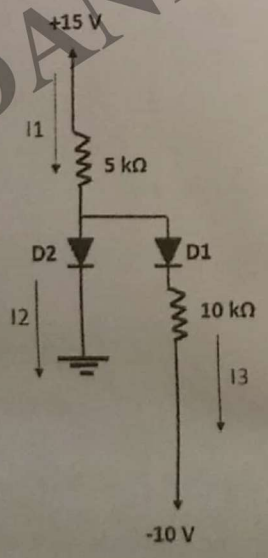


Figure 4

25. Referring to figure 4, if the diodes D1 and D2 are ideal, find the value of the current I3.

a) 1 mA
b) 1.5 mA
c) 2.5 mA
d) 2.5 A

26. With reference to figure 4, if the diode D2 is reverse biased, what would be the value of the current I3?
    a) 0.5 mA
    b) 1.0 mA
    c) 1.5 mA
    d) 1.67 mA

Use figure 5 to answer questions 27 to 30

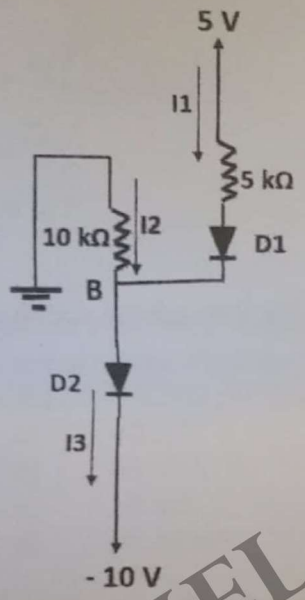


Figure 5

27. Assume the diodes in figure 5 are ideal, what is the value of the voltage at node B?
    a) 0 V
    b) -10 V
    c) 5 V
    d) 0 kV

28. What is the value of the current I3?
    a) 1 mA
    b) 2 mA
    c) 3 mA
    d) 4 mA

29. If the diode D1 is now reverse biased what will be the value of the current I3?
    a) 1 mA
    b) 2 mA
    c) 3 mA
    d) 0.33 mA

30. If the diode D2 is now reverse biased what will be the value of the current I1?
    a) 1 mA
    b) 2 mA
    c) 3 mA
    d) 0.33 mA

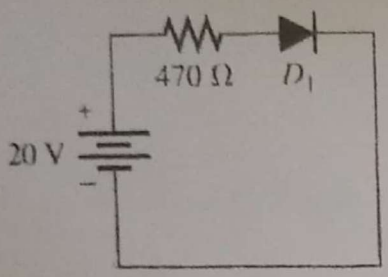


Figure 6

31. Referring to the circuit in figure 6, estimate the current flowing through the circuit using the piece-wise linear model with $V_{DO} = 0.65$ V and $r_D = 20\ \Omega$
    a) 39.4 mA
    b) 0.394 mA
    c) 0.041 mA
    d) 0.41 mA

32. Referring to the circuit in figure 6, estimate the diode voltage using the piece-wise linear model with $V_{DO} = 0.65$ V and $r_D = 20\ \Omega$
    a) 0.7 V
    b) 0.65 V
    c) 0.75 V
    d) 1.44 V

33. Referring to the circuit in figure 6, estimate the current flowing through the circuit using the constant drop voltage model
    a) 39.4 mA
    b) 0.394 mA
    c) 0.041 mA
    d) 0.041 A

In the forward bias region, the i-v characteristics of the real diode is governed by the equation

$$i = I_S\left(e^{V/nV_T}\right) - - - 1$$

Where I, is the diode current and v, the diode voltage.

34. The constant V_T in equation 1 is called the
    a) Terminal voltage
    b) Threshold voltage
    c) Thermal voltage
    d) Constant voltage

35. The constant V_T is given by the expression, (where k is the Boltzmann constant, T is the absolute temperature of the p–n junction, and q is the magnitude of charge of an electron)
    a) $V \equiv kT/q$
    b) $V \equiv kq/T$
    c) $V \equiv Tq/k$
    d) $V \equiv kqT$

36. Consider two diode voltages V_1 and V_2 with corresponding currents I_1 and I_2 at room temperature. Find the voltage drop corresponding to a decade change in current for n = 1.
    a) 60 mV,
    b) 63 mV,
    c) 50 mV,
    d) 54.36 mV

37. A BJT is a:
    A. Current – controlled device
    B. Voltage controlled device
    C. Power controlled device
    D. None of the above

38. The arrowhead on the transistor symbol points in the direction of
    A. Electron flow in the emitter region.
    B. Minority carrier flow in the emitter region.
    C. Majority carrier flow in the remitter region.
    D. Conventional current flow in the emitter region

39. A BJT is in the saturation region if:
    A. Base-emitter junction is reverse-biased and base-collector junction is forward-biased
    B. Both junctions are reverse-biased
    C. Both junctions are forward-biased
    D. Base-emitter junction is forward-biased and base-collector junction is reverse-biased

40. In a bipolar junction transistor the base region is made very thin so that
    A. Recombination in base region is minimum
    B. Electric field gradient in base is high
    C. Base can be easily fabricated
    D. Base can be easily biased

41. β or β_{DC} is the symbol for the
    A. Common emitter current gain
    B. Common collector current gain
    C. Common base current gain
    D. None of the above

42. The value of α is always
    A. > 1
    B. < 1
    C. < 0
    D. $= 1$

43. A transistor has

    I. Collector, II. Emitter, and III. Base

    In a PNP transistor the electron flows into the transistor at

    A. I only

    B. II only

    C. II and III only

    D. I and III only

44. A transistor has a β or β_{DC} of 250 and a base current, I_B, of 20 μA. The collector current, I_C, equals:
    A. 500 μA
    B. 5 mA
    C. 50 mA
    D. 5 A

45. With the positive probe on an NPN base, an ohmmeter reading between the other transistor terminals should be:
    A. Open
    B. Infinite
    C. low resistance
    D. high resistance

46. A transistor may be used as a switching device or as a:
    A. fixed resistor
    B. tuning device
    C. rectifier
    D. variable resistor

47. Transistors (BJT) of certain type are specified to have β in range 50 to 150. Find the range of their α values.
(A) 0.97 to 0.993
(B) 0.98 to 0.993
(C) 0.0196 to 6.6×10^{-3}
(D) None of the above

48. Calculate β for two transistors for which α = 0.99 and 0.98.
(A) 99 ; 49
(B) 0.99 ; 0.98
(C) –99 ; - 49
(D) None of the above

49. For collector currents of 10mA, Find the base current of the transistors in question48.
(A) 99mA; 49mA
(B) 0.1mA; 0.2 mA
(C) 0.1mA; 0.02mA
(D) 10mA; 2mA

50. In a transistor, collector current is controlled by:
A. collector voltage
B. base current
C. collector resistance
D. all of the above

51. What does a reading of a large or small resistance in forward- and reverse-biased conditions indicate when checking a transistor using an ohmmeter?
A. Faulty device
B. Good device
C. Bad ohmmeter
D. None of the above

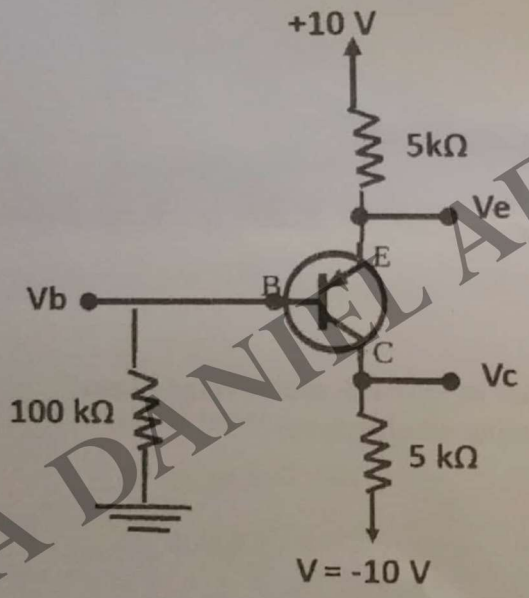
52. For normal operation of a **PNP** BJT, the base must be _____ with respect to the emitter and _____ with respect to the collector
A. positive, negative
B. positive, positive
C. negative, positive
D. negative, negative

53. For a silicon transistor, when a base-emitter junction is forward-biased, it has a nominal voltage drop of.
A. 0.7 V
B. 0.3 V
C. 0.2 V
D. 0 V

54. When a transistor is used as a switch, it is stable in which two distinct regions?
A. saturation and active
B. saturation and cutoff
C. active and cutoff
D. none of the above

55. A certain transistor has $I_C = 15$ mA and $I_B = 167$ μA; β is:
A. 15
B. 167
C. 0.011
D. 90

56. In the circuit shown below, measurement indicates V_B to be +1.0V and V_E to be +1.7V. What is β for this transistor?

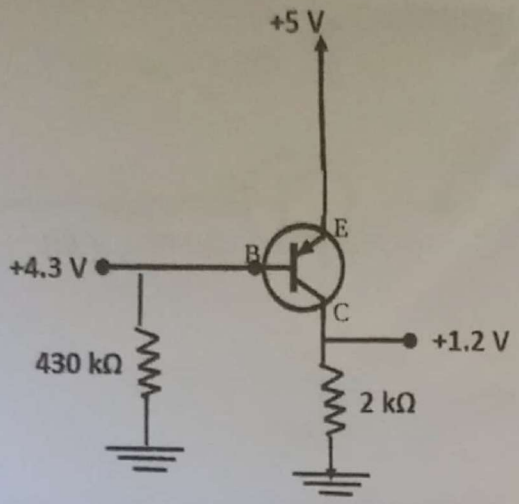


(A) 100
(B) 101
(C) 99
(D) 165

57. What voltage V_C do you expect at the collector in question 56?
(A) -1.72 V
(B) -1.73 V
(C) -1.74 V
(D) -1.75 V

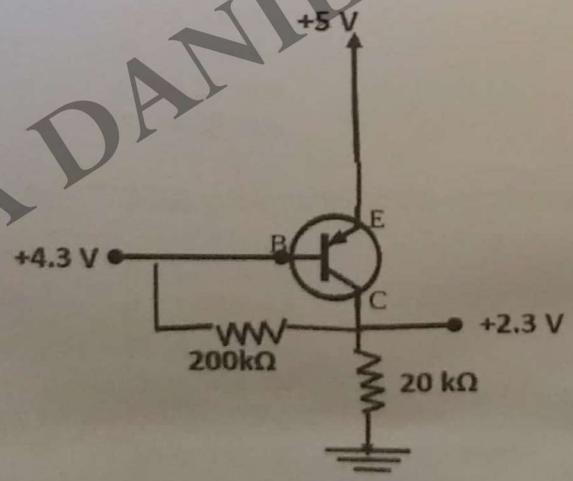
Measurements on the circuits in question 58 and 59, produce labeled voltages as indicated. Find the value of β for each transistor.

58.



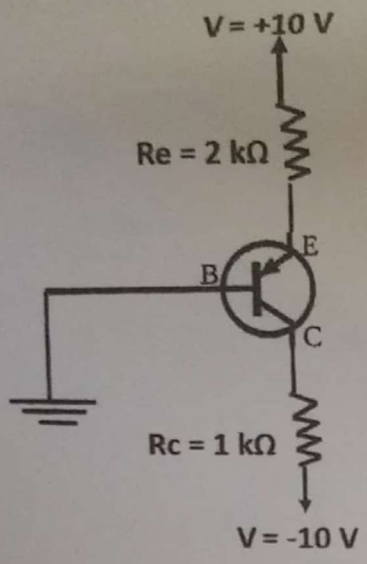
(A). 98
(B). 60
(C). 100
(D). 101

59.



(A). 98
(B). 99
(C). 50
(D). 11.5

Use the circuit shown below to answer questions 60 to 63. Take $\beta = 100$.



60. What is the value of the current flowing through the emitter?

A. 4.65 mA
B. 4.67 mA
C. 4.66 mA
D. 4.66 MA

61. What is the value of the base current?

A. 0.05 mA
B. 0.0 mA
C. 0.03 mA
D. 0.02 mA

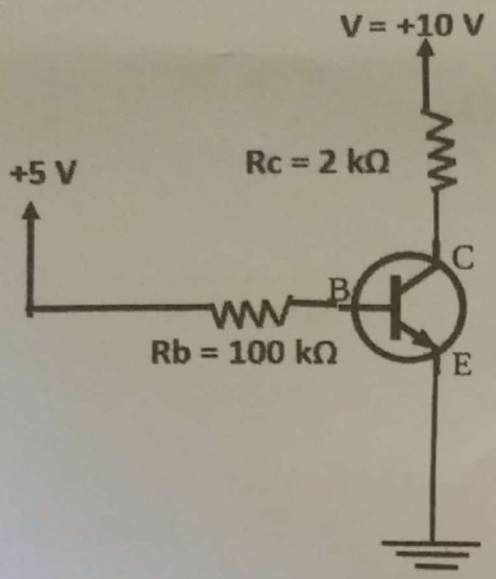
62. What is the value of the collector current?

A. 4.6 mA
B. 4.71 mA
C. 4.70 mA
D. 4.4 mA

63. What voltage would you expect at the emitter?

A. 0.4 V
B. 1.7 V
C. -0.7 V
D. 0.7 V

Use the circuit shown below to answer questions 64 to 67. Take $\beta = 100$.



64. What is the value of the base current?

A. 0.043 mA
B. 0.034 mA
C. 0.044 mA
D. 0.033 mA

65. What is the value of the current flowing through the collector?

A. 4.3 mA
B. 4.2 mA
C. 4.32 mA
D. 4.23 mA

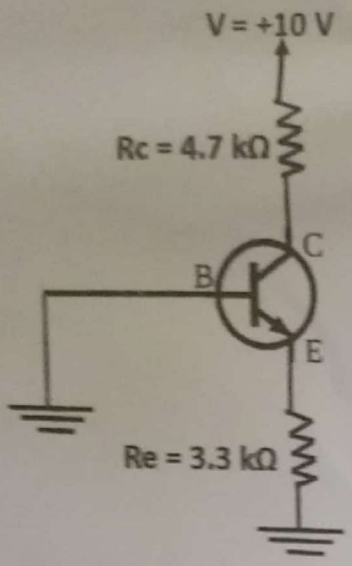
66. What is the value of the emitter current?

A. 4.443mA
B. 4.343 mA
C. 4.434 mA
D. 4.344 mA

67. What voltage would you expect at the emitter?

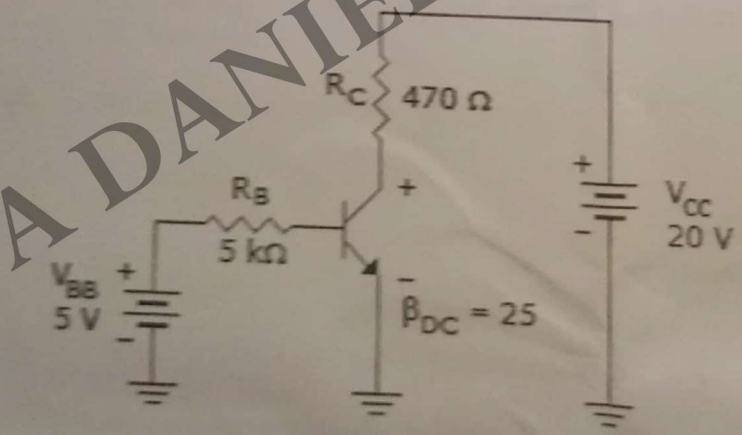
A. 0.7 V
B. 1.7 V
C. 0.17 V
D. 0.0 V

68. What is the mode of operation of the transistor below?



a). Active
b). Saturation
c). Cut off
d). would need more information

69. Refer to this figure. The value of V_{BE} is:



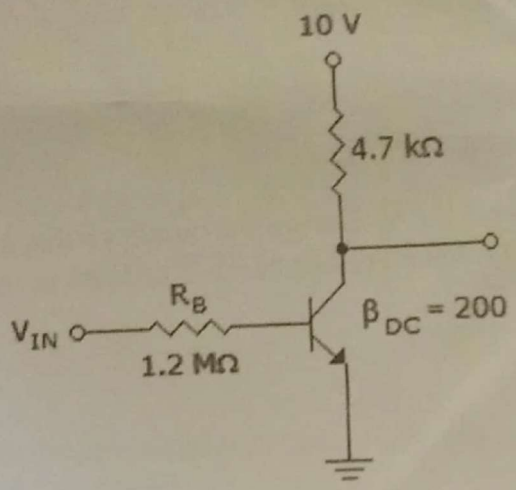
[A]. 0.6 V

[B]. 0.7 V

[C]. 1.2 V

[D]. 0.079 V

70. Refer to this figure. If $V_{CE} = 0.2$ V, I_C is:



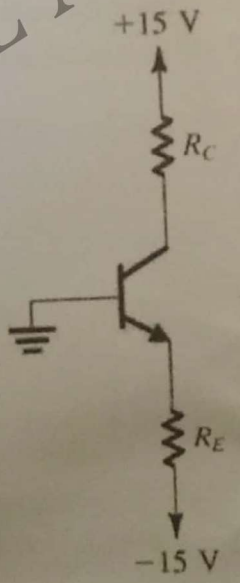
[A]. 0.05 mA

[B]. 2.085 mA

[C]. 1.065 mA

[D]. 7.4 mA

Use the figure below to answer questions 71, 72 and 73



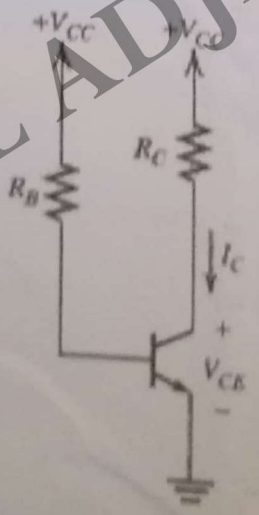
71. The transistor above has $\beta = 100$. What is the value of the resistance required for a current of 4.3 mA to flow through the emitter?

A. 3.33 Ω
B. 3.33 kΩ
C. 3.65 Ω
D. 3.65 kΩ

72. For an emitter current of 4.3 mA what is the value of the base current?
A. 0.043 mA
B. 0.044 mA
C. 0.434 mA
D. 0.44 mA

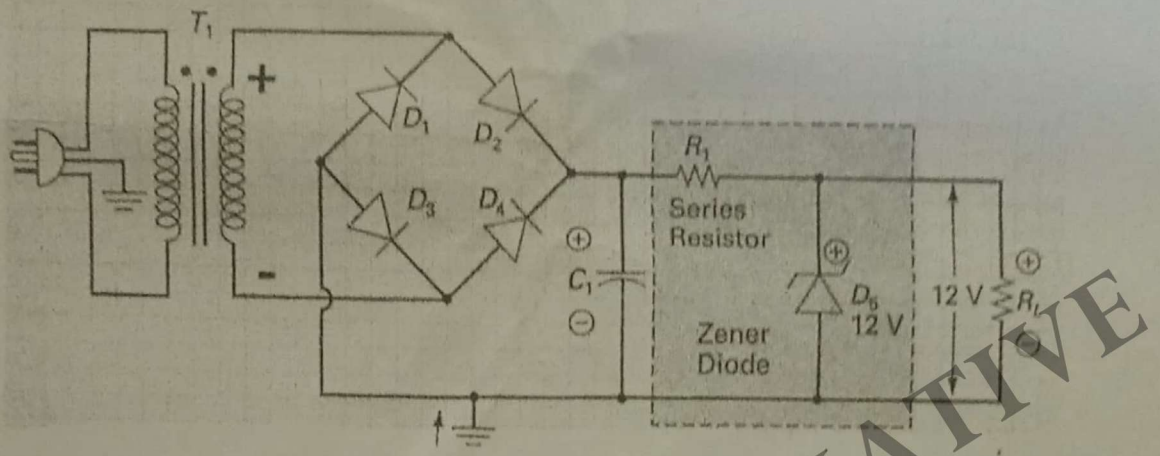
73. If the transistor exhibits an Ic=1mA at V_{BE} = 0.7 V. Design the circuit so that a current of 5 mA flows through the collector and a voltage of +5 V appears at the collector.
A. R_c = 1k
B. R_c = 5k
C. R_c = 2k
D. R_c = 3k

74. The transistor below has V_{CC} = 15 V, and β = 100. Design the circuit for a base current of 0.0715 mA.



A. R_B = 200 kΩ
B. R_B = 100 kΩ
C. R_B = 100 Ω
D. R_B = 20 kΩ

Use the figure below to answer questions 75 to 80



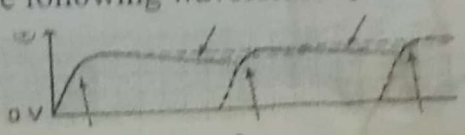
75. If the bridge rectifier is biased with the polarity shown in the figure, which of the diodes would be turned on?
    A. D_1 and D_2
    B. D_3 and D_2
    C. D_1 and D_3
    D. D_4 and D_1

76. The rectifier above is called a full wave rectifier because
    A. It uses a quarter of each half of the input sinusoid
    B. It uses half of the input sinusoid
    C. It uses both halves of the input sinusoid
    D. Because it uses alternate halves of the input sinusoid

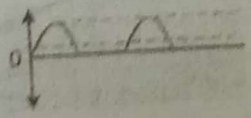
77. The function of the capacitor in the circuit is
    A. To store charges
    B. To act as a filter
    C. To replace the EMF
    D. To regulate the voltage

78. The function of the zener diode is to ensure that
    A. A constant current is delivered at the output of the circuit irrespective of voltage fluctuations in the mains supply
    B. A constant voltage is delivered at the output irrespective of current fluctuations in the circuit
    C. The ripples in the input sinusoid are reduced
    D. The fuse does not blow up

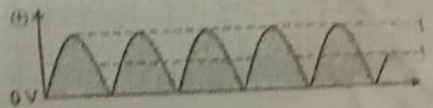
79. Which of the following waveform is produced at the output of the bridge rectifier?



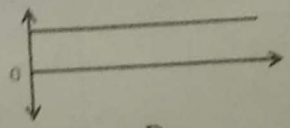
A



B

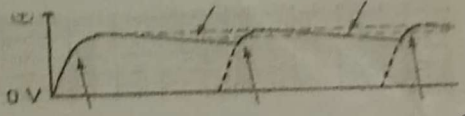


C

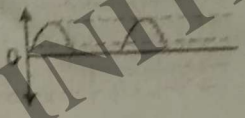


D

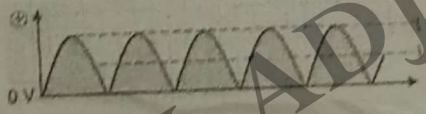
80. Which of the following waveform is produced at the output of the capacitor?



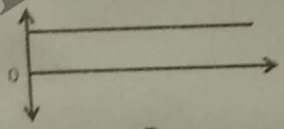
A



B



C



D

F. K. Ampong