Section 1 (35 points): Multiple choices, select the most appropriate one. Each problem weights 1 point.

1. An ideal voltage source has:
   a. Zero internal resistance
   b. Infinite internal resistance
   c. A load-dependent voltage
   d. A load-dependent current

2. An ideal current source has:
   a. Zero internal resistance
   b. Infinite internal resistance
   c. A load-dependent voltage
   d. A load-dependent current

3. To get the Norton current, you have to
   a. Short the load resistor
   b. Open the load resistor
   c. Short the voltage source
   d. Open the voltage source

4. If a load resistance is 100 Ω, a stiff current source has a internal resistance of
   a. Less than 1 Ω
   b. Less than 10 Ω
   c. Less than 10 kΩ
   d. More than 10 kΩ

5. What type of atoms is added to molten silicon in order to increase the number of holes?
   a. pentavalent b. trivalent c. covalent d. negative

6. Electrons are the minority carries in which type of semiconductors?
   a. Extrinsic b. Intrinsic c. *n*-type d. *p*-type

7. When the reverse voltage decreases from 10 to 5 V, the depletion layer
   a. Becomes smaller
   b. Becomes larger
   c. Is unaffected
   d. Breaks down

8. What is the term for reverse current on the surface of a crystal?
   a. crystal current
   b. reverse current
   c. surface-leakage current
   d. avalanche breakdown current

9. The surface-leakage current doubles when the reverse voltage increases
   a. 7% b. 100% c. 200% d. 2 mV

10. What kind of a device is a resistor?
   a. Bilateral b. Linear c. Nonlinear d. Unipolar

11. The reverse current consists of minority-carrier current and
   a. Avalanche current
   b. Forward current
   c. Surface-leakage current
   d. Zener current

12. How much load current is there in Figure 1 with the second approximation?

   a. 0
   b. 10 mA
   c. 9.3 mA
   d. 1.7 mA

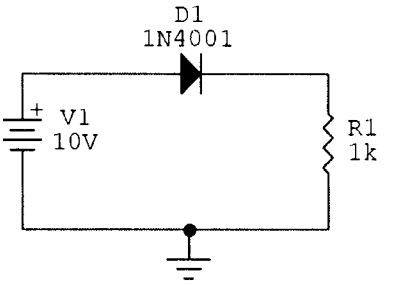


Figure 1

KVL: $10V - 0.7V - IR = 0$

$IR = 10V - 0.7V$

$I = \frac{9.3V}{1k} = 9.3mA$

$N_p = 5 \quad N_s = 1$

$V_s = V_{pri} \quad V_s = 115V\left(\frac{N_s}{N_p}\right) = 115V\left(\frac{1}{5}\right)$

13. A transformer has a turns ratio of 5:1 and the primary voltage is 115 V rms, what is the rms secondary voltage?
   a. 15 V b. 23 V c. 30 V d. 35 V

$V_s = V_{rms} \cdot \sqrt{2}$

$V_s = 17.82V$

$V_s =$

14. What is the peak load voltage out of a BRIDGE rectifier for a secondary voltage of 12.6 V rms (use second approcimation)?
   a. 7.5 V (b) 16.4 V c. 17.8V d. 19.2V

$V_r = \frac{I_L}{5C}$

15. If the load current is 5 mA, the line frequency is 60 Hz, and the filter capacitance is 1000 uF, what is the peak-to-peak ripple out of the a full-wave rectifier?
   a. 21.3 mV b. 21.3 nV (c) 41.7 mV d. 83.3 mV

16. With the same secondary voltage and filter, which has the most ripple?
   a. Half-wave rectifier
   b. Full-wave rectifier
   c. Bridge rectifier
   d. Impossible to say

17. The diodes in a bride rectifier each have a maximum dc current rating of 2 A. This means that the dc load current can have a maximum value of
   a. 1A b. 2A (c. 4A) d. 8A

18. A circuit that removes positive or negative parts of a waveform is called a
a. Clamper (b. Clipper) c. Diode clamp d. Limiter

19. which of these is the best description of a zener diode?
a. It is a rectifier diode
b. It is a constant-voltage device
c. It is a constant-current device
d. It works in the forward region

20. As compared to a silicon rectifier, an LED has a
a. Lower forward voltage and lower breakdown voltage
b. Lowe forward voltage and higher breakdown voltage
c. Higher forward voltage and lower breakdown voltage
d. Higher forward voltage and higher breakdown voltage

21. A photodiode is normally
a. Forward biased
b. Reverse biased
c. Neither forward nor reverse biased
d. Emitting light

22. In a npn transistors, the majority carriers in the emitter are
a. Free electrons
b. Holes
c. Neither
d. Both

23. If the current gain is 100 and the collector current is 10 mA, the base current is
a. 10 uA (b. 100 uA) c. 1A d. 10A

24. In the active region, the collector current is not changed significantly by
a. Base supply voltage
b. Base current
c. Current gain
d. Collector resistance

25. When the collector current increases, what does the current gain do?
a. Decreases (b. Stays the same) c. Increases d. Any of the above

26. Ignoring the bulk resistance of the collector diode, the collector-emitter saturation voltage is
a. 0 V
b. A few tenths of volt
c. 1 V
d. Supply voltage

$I_B = \frac{10V - 0.7V}{930K\Omega} = 10\,\mu A$

$I_C = \beta I_B = 1mA$

27. In Figure 2, β = 100 for transistor Q1, the values of resistors and batteries are shown in the diagram. the collector current is

    a. 10 uA
    b. 100 uA
    (c.) 1 mA
    d. 10 mA

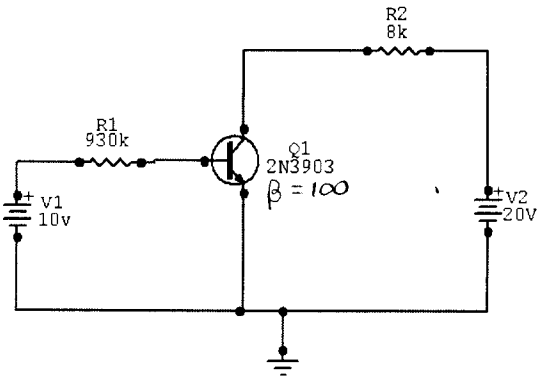


Figure 2

28. If the base resistor R1 has zero resistance in stead of 930 kΩ in Figure 2, the transistor will probably be
    a. Saturated b. In cutoff c. In active region (d.) Destroyed

29. If a transistor operates at the middle of the load line in a base-bias transistor circuit, a decrease in the current gain will move the Q point
    (a.) Down b. Up c. Nowhere d. Off the load line

$I_C = \beta I_B$

$\beta \downarrow = I_C \downarrow$

$= Q \downarrow$

30. Amplifiers that use emitter bias have Q points that
    (a.) are immune to changes in current gain
    b. move up or down the load line with changes in current gain
    c. are not on the load line
    d. are at saturation or cutoff

31. If the current gain is unknown in an emitter-biased circuit, you cannot calculate the
    ~~a.~~ Emitter voltage V_E
    ~~b.~~ Emitter current I_E
    ~~c.~~ Collector current I_C
    (d.) Base current

32. Base bias is associated with
    a. Amplifiers
    (b.) Switching circuits
    c. Stable Q point
    d. Fixed emitter current

R_E

33. If the emitter resistance is reduced by one-half in a voltage-divider bias (VDB) circuit, the collector current will
    a. Double
    b. Drop in half
    c. Remain the same
    d. Increase

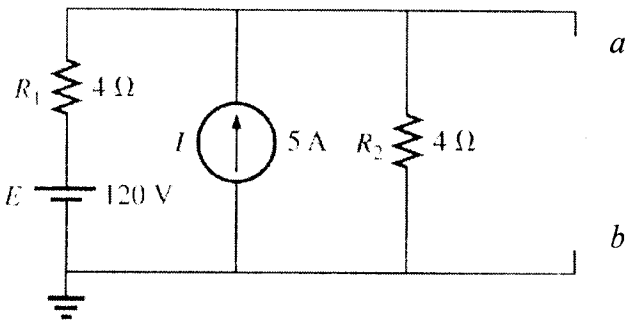
$R_E \downarrow = I_E \uparrow = I_C \uparrow$

34. Which is the largest current in a *pnp* transistor?
    a. Base current
    b. Emitter current
    c. Collector current
    d. None of these

35. The Q point of two-supply emitter biased (TSEB) circuit does not depend on the
    a. Emitter resistance
    b. Collector resistance
    c. Current gain
    d. Emitter voltage

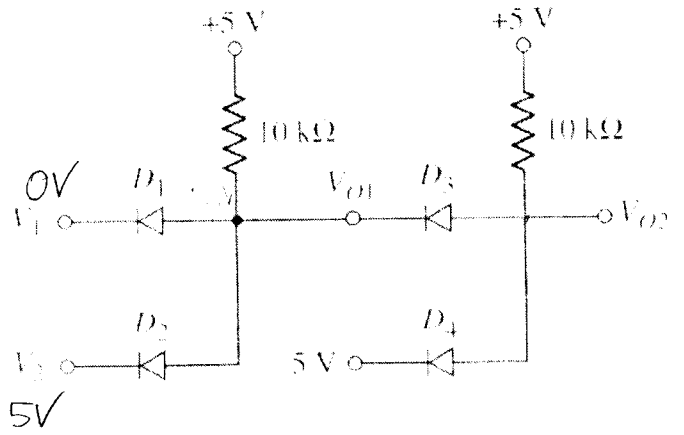
Section 2 (65 points): Calculations.

Problem 1 (10 points): In the following circuit, find (a) Thevenin voltage and resistance, (b) Norton current and resistance between nodes *a* and *b*.

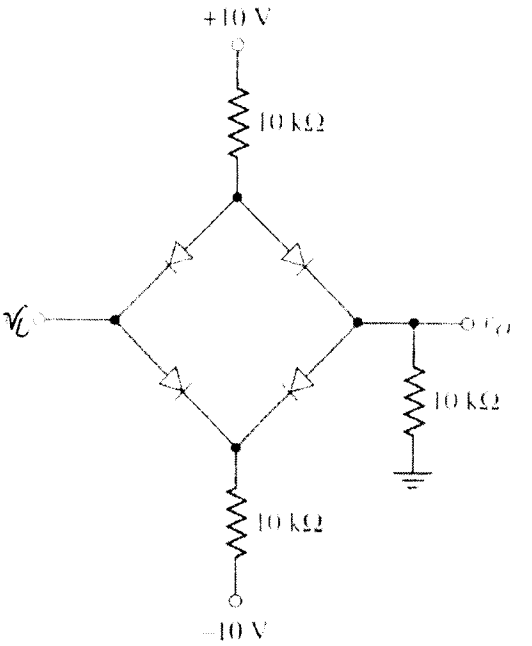


Problem 2 (10 points): A silicon diode has a saturation current (I_{sat}) of 100 nA, and a surface leakage current (I_{leak}) of 50 nA when the reverse voltage is 10V and the temperature is at 20 °C. Determine its saturation current and surface leakage current of the diode if the temperature is at 80 °C while the reverse voltage is 40V.

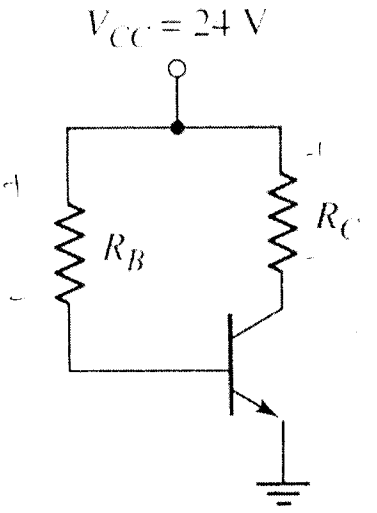
Problem 3 (5 points): In the following diagram find V_{O1} and V_{O2} when (a) $V_1 = V_2 = 5$ V, (b) $V_1 = 0$ V, $V_2 = 5$ V. Use second approximation for the diodes.



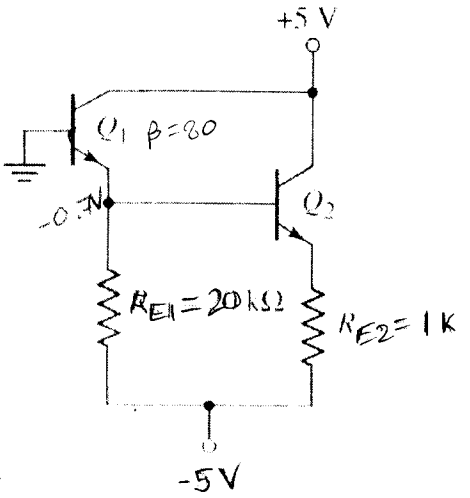
Problem 4 (10 points): In the following circuit, sketch V_O versus V_i for -10 V $\leq V_i \leq$ +10 V. Use the second approximation for the diodes.



Problem 5 (10 points): For the circuit shown below, the *Q*-point is I_{CQ} = 2 mA and V_{CEQ} = 12 V when β = 60. V_{BE} (on) = 0.7 V. (a) Determine the values for R_C and R_B, (b) Sketch the load line and *Q* point, (c) If the transistor is replaced with a new one with β = 100, find the new values of I_{CQ} and V_{CEQ}.



Problem 6 (10 points): For the circuit shown below, $\beta = 80$ and V_{BE} (on) = 0.7 V. Determine the quiescent values of base and emitter currents in Q_1 and Q_2.



Problem 7 (10 points): Design a circuit using the flowing diagram, given that $V^+ = 10V$, $V^- = -10V$, $V_{CEQ} = 0.5\ (V^+ - V^-)$, and $I_{CEQ} = 100$ mA. The transistor parameters are: $V_{BE}(on) = 0.\ 7V$, and $80 \leq \beta \leq 160$. Make sure that the voltage divider is a stiff divider.