EE3203: Power Electronics

Tutorial 1

1. Consider the resistive switching circuit as shown in Fig. 1 with $V_s = 300\,V$, $f_s = 100\,kHz$ and $R = 75\,\Omega$. The switch turn-on time is $150\,ns$ and the turn-off time is $300\,ns$. Assuming linear voltage- and current-switching characteristics, calculate the switching power loss and compare it with the power rating of the devices.

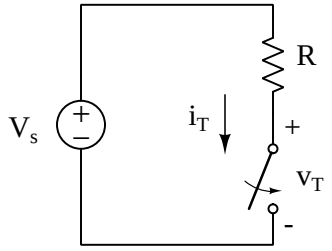

Fig. 1. Resistive switching circuit

2. Determine the possible steady state operating points of the switching devices shown in Fig. 2 in the VI-plane.

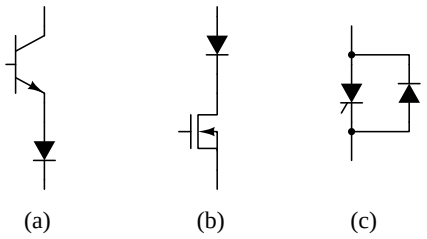

Fig. 2. Various switching devices

3. Fig. 3 shows the current carried by a BJT having an on-state voltage drop of $1.2\,V$. Find the conduction power loss. If this device was replaced by a MOSFET with an on-state resistance of $150\,m\Omega$, calculate the conduction power loss.

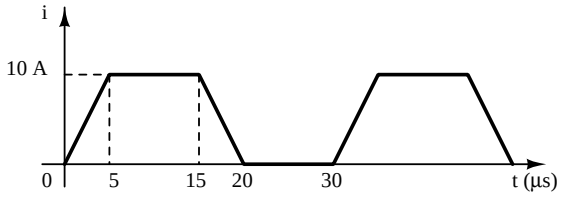

Fig. 3. Current characteristic

4. For the single-phase rectifier circuit shown in Fig. 4, draw the current and voltage waveforms at the input and output sides, and also the voltage across the diode, D_1.

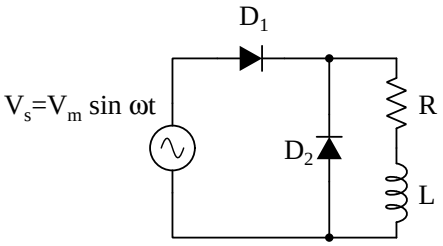

Fig. 4. Single-phase rectifier

5. A dc battery of constant emf, E is being charged through a resistor as shown in Fig. 5. For a source voltage of $230\,V$, $50\,Hz$ and for $R = 8\,\Omega$ and $E = 150\,V$,

   (a) Find the value of the average charging current.

   (b) Find the power supplied to the battery and that dissipated in the resistor.

   (c) Find the input power factor.

   (d) For a battery capacity of 1000 Wh, calculate the charging time.

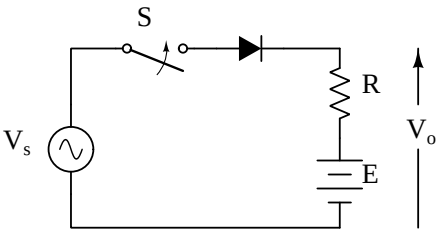

Fig. 5. Battery charging circuit

6. A single-phase full bridge diode rectifier is supplied from $230\,V$, $50\,Hz$ source as shown in Fig. 6. The load consists of $R = 10\,\Omega$ and a large inductance to render the load current constant. Determine:

   (a) Average values of output voltage and current.

   (b) RMS values of input and output currents.

   (c) Input power factor.

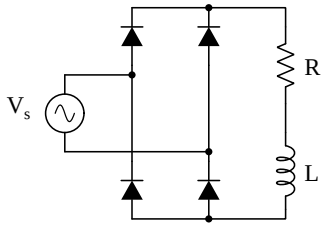

Fig. 6. Single-phase diode bridge rectifier

7. Draw the output current and output voltage waveforms for the circuit shown in Fig. 7.

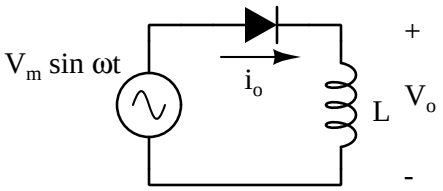

Fig. 7

8. What would be the PIV rating of the diode D shown in the circuit in Fig. 8 given under the following conditions: (Assume $V_m = 325\,V$ and $f = 50\,Hz$)
   (a) With Capacitor, C.
   (b) Without Capacitor, C.

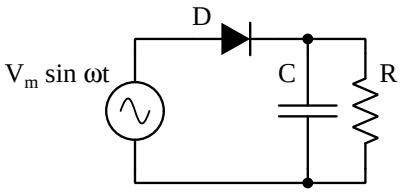

Fig. 8

9. The circuit shown in Fig. 9 produces the current as shown for the given source voltage. Which semiconductor power device can be connected across terminals a and b to produce the same response?
   (a) Diode
   (b) Thyristor
   (c) MOSFET
   (d) IGBT

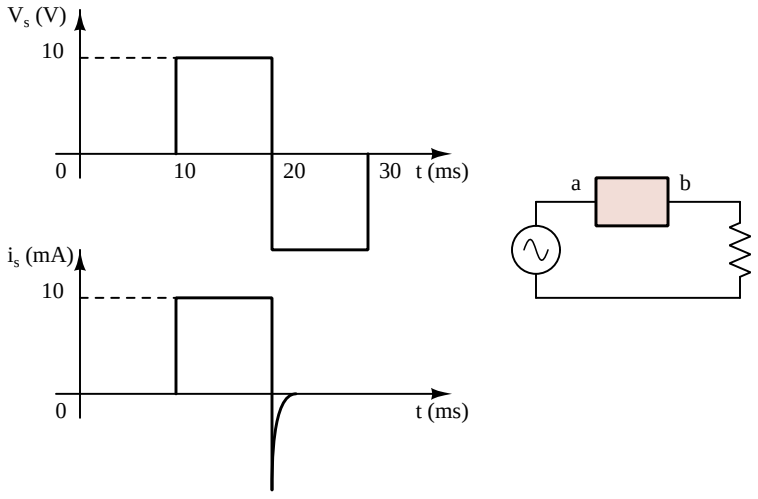

Fig. 9

10. The trigger circuit of an SCR has the source voltage as $15\,V$ and the load line has a slope of $-120\,V/A$. The minimum gate current to turn on the SCR is $45\,mA$. Compute:

    (a) Source resistance required in gate circuit.

    (b) Trigger voltage and trigger current for an average gate power dissipation of $0.4\,W$.

11. Latching current of the SCR given in Fig. 10 is $40\,mA$. What should be the minimum duration of the gate pulse for reliable Turn ON of the SCR?

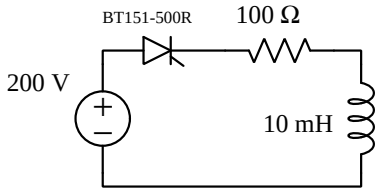

Fig. 10

12. A single-phase diode bridge rectifier is fed from $230\,V$, $50\,Hz$ source and it is connected to a load of $R = 400\,\Omega$.

    (a) Design a capacitive filter so that the ripple factor of the output voltage is less than $5\,\%$.

    (b) Determine the average output voltage with the value of C obtained and also without the filter.