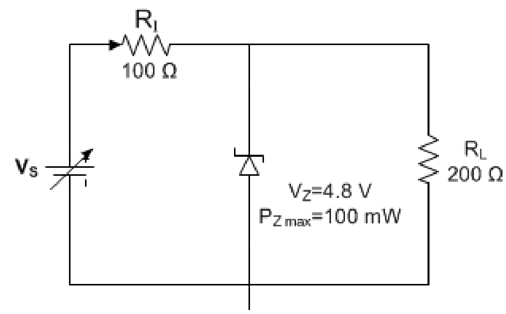
Department of Electronics and Electrical Engineering
EE101: Electrical Science
End-Semester Examination (July – November, 2011)

Maximum Marks: 50 **Time: 3 Hours**

Attempt all questions. Credit for each question is shown in the square bracket.

1. In the circuit shown in Fig. 1, the Zener diode's zener voltage is $V_z = 4.8$ V. Its maximum power dissipation should be less than 100 mW and it requires a minimum current of 1 mA for zener operation.

Calculate the range of the source voltage V_s that can be used. **[5]**



2. Find the bias point (Q-point) of the transistor in the circuit shown in Fig. 2. Assume that the transistor has β=20 when it is working in the active region and $V_{CE,\,sat}$ =0.1 V when it is in saturation. **[5]**

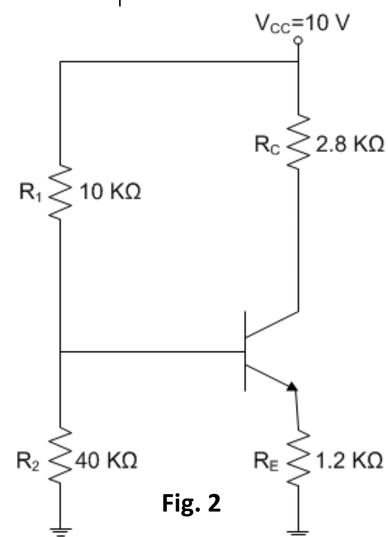


Fig. 2

3. Use D flip flops (and logic gates, as required) to construct a 2-bit counter which counts in the Gray-code sequence, i.e. 00, 01, 11, 10, 00, ….. **[5]**

4. Consider the function –

$$Y=\bar{A}\bar{B}\bar{C}D + \bar{A}\bar{B}CD + \bar{A}B\bar{C}\bar{D} + A\bar{B}\bar{C}\bar{D} + A\bar{B}\bar{C}D + \bar{A}BC\bar{D} + A\bar{B}CD + ABC\bar{D}$$

(a) Draw the Karnaugh Map for Y **[1]**

(b) Use the Karnaugh Map to simplify Y **[2]**

(c) Implement the reduced expression using only NAND gates. (The NAND gates can have any number of inputs that you may require. You can also assume that the complemented variables are available.) **[2]**

5. Find the gain $A_V = \frac{V_O}{V_I}$ of the circuit shown in Fig. 3. **[5]**

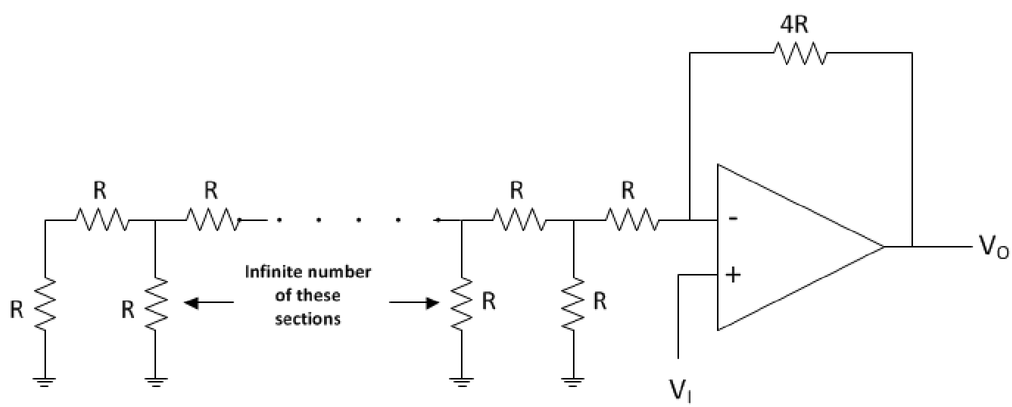


Fig. 3

6. Applying Superposition theorem determine the current I in the circuit shown in Fig. 4. Show steps in your answer. No marks if will be given if steps are not shown. **[5]**

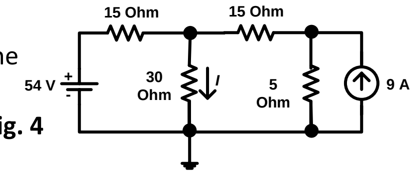


Fig. 4

7. The core shown in Fig. 5 has the flux f shown in Fig. 6. Sketch the voltage present at the terminals of the coil. [**5**]

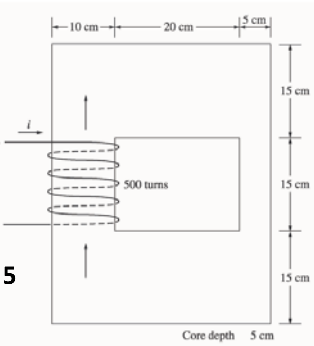


Fig. 5

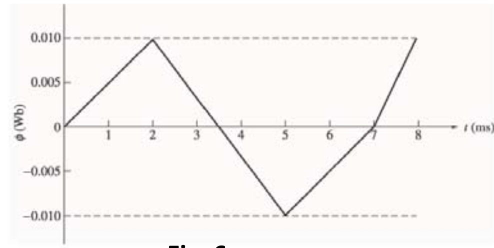


Fig. 6

8. Fig. 7 shows a simple single-phase ac power system with three loads. The voltage source is $V = 120\angle 0^o \, volts$ and the three loads are: $Z_1 = 5\angle 30^o \Omega \quad Z_2 = 5\angle 45^o \Omega \quad Z_3 = 5\angle -90^o \Omega$

Answer the following questions

a. Assume that the switch shown in the figure is open, and calculate the current **I**, the power factor, and the real, reactive, and apparent power being supplied by the source. **[2]**

b. Assume that the switch shown in the figure is closed, and calculate the current **I**, the power factor, and the real, reactive, and apparent power being supplied by the source. [**2**]

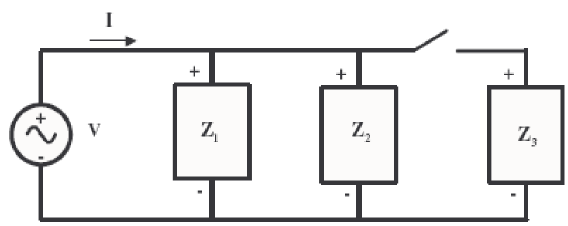


Fig. 7

c. What happens to the current flowing from the source when the switch is closed? Why? [**2**]

9. A 440-V, 50-Hz, six-pole induction motor has a slip of 6 percent when a mechanical load of 50kW is connected rotor. The friction and windage losses are 300 W, and the core losses are 600 W. Find the following values:

a. The mechanical speed of the rotor in rpm. [**2**]
b. The shaft torque [**1**]
c. The air gap torque [**1**]
d. The frequency of the induced emf in the rotor [**1**]

10. When it is necessary to stop an induction motor very rapidly, many induction motor controllers reverse the direction of rotation of the magnetic fields by switching any two stator leads. When the direction of rotation of the magnetic fields is reversed, the motor develops an induced torque opposite to the current direction of rotation, so it quickly stops and tries to start turning in the opposite direction. If power is removed from the stator circuit at the moment when the rotor speed goes through zero, then the motor has been stopped very rapidly. This technique for rapidly stopping an induction motor is called *plugging*.

A 460-V, four-pole, 50-Hz, Y-connected three-phase induction motor is connected to a mechanical load and the rotor is rotating at 3 percent slip.

a. What is the slip *s* before plugging? [**1**]
b. What is the frequency of the rotor before plugging? [**1**]
c. What is the slip *s* immediately after switching the stator leads? [**1**]
d. What is the frequency of the rotor immediately after switching the stator leads? [**1**]