Department of Electronics and Electrical Engineering, IIT Guwahati

Electrical Sciences: EE101

Time: 3 hours **End Semester Exam (24 Nov'14)** **Max. Marks: 50**

Instructions: *1. There are **six (6)** questions in total and **all** are to be attempted.*

*2. Solve **all parts of a question** together at one place in the answer script.*

Q1. (a) For the circuit shown in Fig 1(a), find the value of V_o. **[2]**

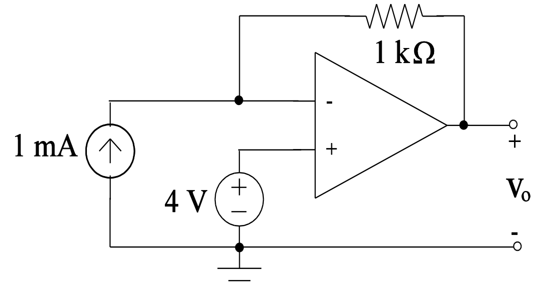

Fig 1(a)

(b) Figure 1(b) shows a voltage source v_s driving a load R_L through an amplifier whose some of the relevant parameters are known. Determine the required voltage gain of amplifier A_v such that an overall current gain (i_o/i_s) of 120 is achieved. **[2]**

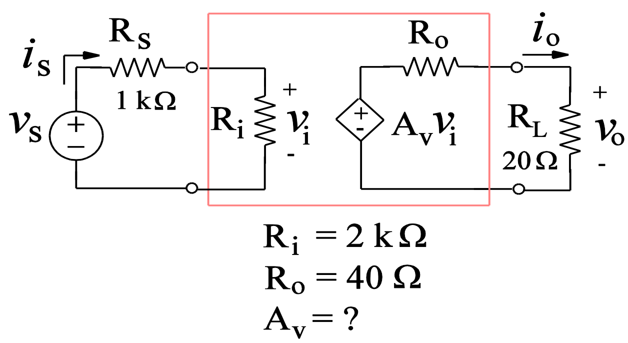

Fig 1(b)

(c) Find the Gray code for the number obtained by addition of 127_8 and $5E_{16}$. **[3]**

(d) For the circuit shown in Fig 1(d), the transistors are matched with $\beta = 80$ and $V_{BE\,(\text{on})} = 0.7\ V$. Determine the value of I_{ref} and R in order to achieve $I_o = 0.7\ mA$. **[2+1]**

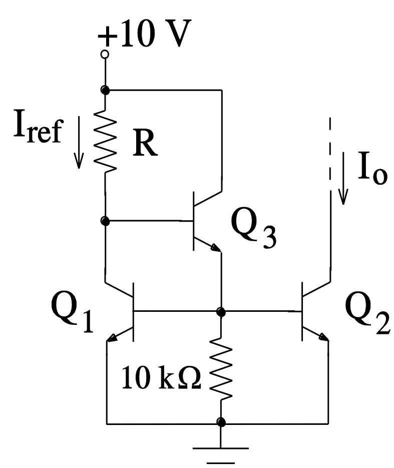

Fig 1(d)

Q2. (a) For the circuit shown in Fig 2(a), if the switch is kept open and $R_1 = R_2 = R_3 = 10\ k\Omega$, find the minimum and the maximum value of v_o obtained by varying the potentiometer over the full range. **[1+1]**

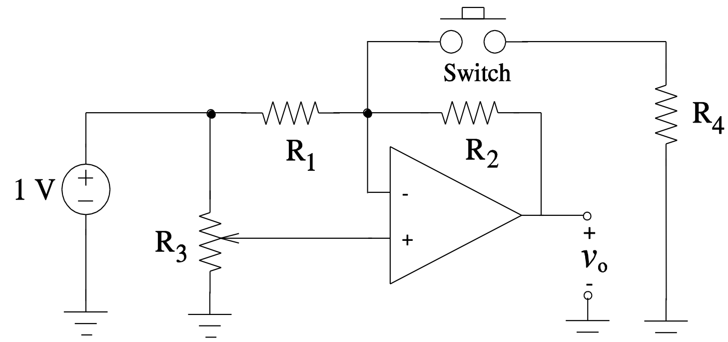

Fig 2(a)

(b) In the circuit shown in Fig 2(a), the switch is now closed. Find the minimum and the maximum value of v_o obtained by varying the potentiometer over the full range, if R_4 is $2.5\ k\Omega$. **[1.5+1.5]**

(c) In reference to part (b), if you are required to set the minimum v_o such that its absolute value is 5 V. What value of R_1 will you choose? **[2]**

Q3. (a) It is required to design a combinational logic circuit which has a BCD number as input and produces 1 (high) as output whenever the number of 1s in the input word is ≥ 2.

i. Find the minimized expression for the logic circuit using K-map. **[2]**
ii. Realize the minimized logic circuit using NOT, OR and AND gates **[1]**
iii. Realize the minimized logic circuit using only NAND gates. **[1]**

(b) Fig 3(b) shows a logic circuit that uses a sub-module with 3-inputs (X1, X2, X3) and 1-output (Z) characterized by the truth table given below:

X1	X2	X3	Z
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

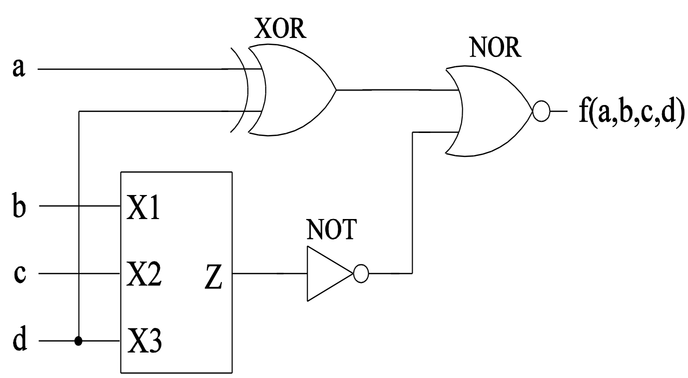

Fig 3(b)

i. Draw the truth table for the logic circuit f(a, b, c, d). **[2]**
ii. Find the minimized expression for logic circuit using K-map. **[1]**
iii. Realize the minimized logic circuit using only NOR gates. **[1]**

Q4. A simple magnetic circuit with the dimensions of the core is shown in Fig 4. The relative permeability of the core material is 30,000. ($\mu_0 = 4\pi \times 10^{-7}$). The coil has 200 turns.

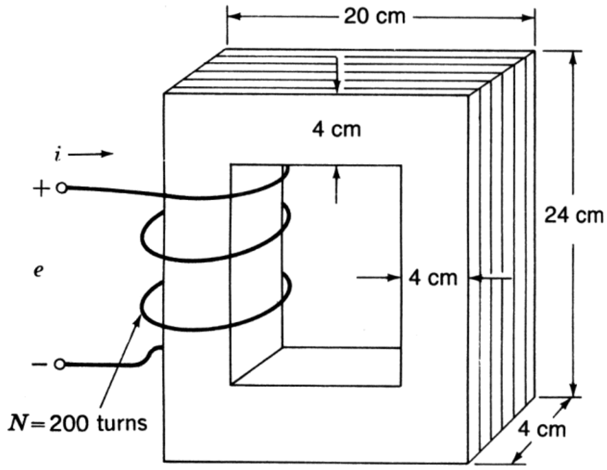

Fig 4

It is desired to achieve a flux density of $1.5\, sin\, 377t$ (T) in the core.

(a) Find the expression for the applied voltage *e* as a function of time. **[1+1+1]**

(b) What are the peak values of (i) the flux produced in the core, and (ii) the current drawn by the coil? **[1+2]**

(c) What is the inductance of the coil and what is the peak value of the energy stored in the coil? **[1+1]**

Q5. The short circuit test conducted on the high voltage side of a 1-phase, 60 kVA 2400/150 V, 50 Hz transformer gave the following measurements:

Voltage applied 100 V, Current drawn = 25 A, and Power input = 1280 W

The core loss of the transformer is known to be 0.8 kW.

(a) Draw the approximate equivalent circuit of the transformer referred to the high voltage side, showing the numerical values of the circuit parameters. Ignore the shunt components. **[1+1+1]**

(b) If the transformer supplies a load of 40 kW at a power factor of 0.8 (lag) at raged terminal voltage of 150 V,

i. Find the efficiency of the transformer. **[2+1+1]**

ii. Calculate the input voltage to the transformer **[2]**

Q6. A 3-phase induction motor is rated 100 kW, 400 V, 50 Hz.

The speed of the motor was found to be 1470 rpm when developing a total mechanical power of 50 kW.

(a) Find the number of poles of the machine. Draw the equivalent circuit for the rotor circuit referred to the stator, showing the parameters responsible for the mechanical power developed and the rotor copper loss. **[1+1+1]**

(b) Calculate the frequency of the rotor current and the speed of the rotor flux relative to the rotor. **[1+1]**

(c) Calculate the rotor copper loss and the total power crossing the air gap to the rotor. **[1+2]**