EE-101, Introduction to Electrical and Electronic Circuits

End-Sem Exam

Tuesday, 14th Nov.'2017
2:00 p.m. - 5.00 p.m.

Max. Marks: 70
Overall Weightage : 50%

Note : (a) Be brief and to the point.
(b) If a question has multiple parts, answer them in one place.
(c) Symbols have the usual meanings as used in the lectures.

1. Sketch v_o and v_{D1} versus time (for one time period of the input voltage) for the circuit shown in Fig. 1.1 with $v_{in} = 40 \times \sin(100\pi \cdot t)$ V. Assume the diodes to be ideal (i.e. $v_\gamma = 0$V and $r_{on} = 0\Omega$). (5)

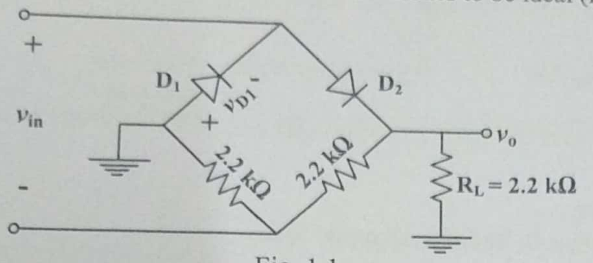

Fig. 1.1

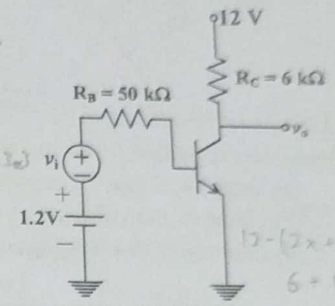

Fig. 2.1

$1.2 + x - 50 i_B - 0.7 = 0$

$50 i_B = 0.5 + x$

$i_B = \left(\frac{0.5}{50} + \frac{x}{50}\right) 10^{-3}$

$i_C = (1+2x)\, 10^{-3}$

2. (a) For the circuit shown in Fig. 2.1, determine the voltage gain (v_o/v_i) of the transistor amplifier. Also, draw the simplified hybrid-π model for the small-signal operation of the BJT. Assume: $\beta = 100$ and $V_{BE} = 0.7$V.
(b) An N channel MOSFET with threshold voltage $V_T = 1$ V has a drain current $i_D = 0.8$ mA when $v_{GS} = 3$V and $v_{DS} = 4.5$V. Calculate the drain current when: (a) $v_{GS} = 2$ V, $v_{DS} = 4.5$ V; and (b) $v_{GS} = 3$ V, $v_{DS} = 1$ V. (8+2)

3. Determine the complete current response of an 'under-damped' series R-L-C circuit to sinusoidal voltage excitation, $E_m \cos \omega t$ in the standard form. Describe the current behavior using hypothetical waveform(s). (7)

4. (a) How are the phasors useful in analyzing AC circuits?
(b) For the circuit shown in Fig. 4.1, use Thevenin's theorem to obtain the current, I_3 if $Z_3 = (4 + j3)\Omega$. Given that $V_1 = 20\angle 0°$ V, $V_2 = 30\angle -40°$ V, $Z_1 = (7 + 3j)\ \Omega$ and $Z_2 = (7 - 3j)\ \Omega$. (2+6)

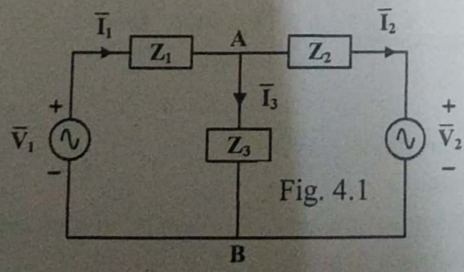

Fig. 4.1

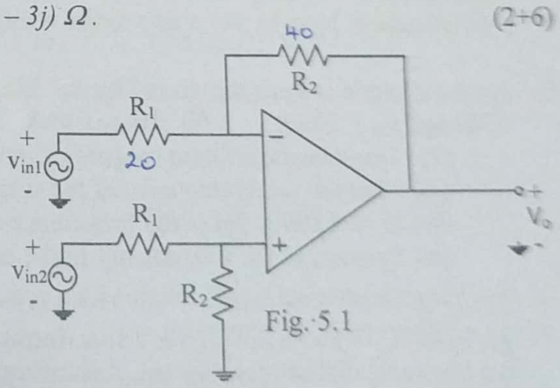

Fig. 5.1

5. (a) For the Op-Amp circuit shown in Fig. 5.1, determine the output voltage V_o. Given: $v_{in1} = 20 \sin(\omega t)$ mV, $v_{in2} = 30 \cos(\omega t)$ mV, $R_1 = 20$ kΩ and $R_2 = 40$ kΩ.
(b) In the charging circuit of a dual slope ADC [Fig.5.2(a)], $V_{ref} = 15$V and run-up time (t_u) = 10ms [Fig.5.2(b)]. In the ADC, a 13-bit binary ripple counter used to count the clock pulses during the ramp-down time (t_d).
a. Find the clock frequency such that all the 13-bit outputs are high when $v_{in} = 15$V.
b. Determine the resolution of the designed ADC.
c. If the manufacturing error introduces 29.1478452 ns delay in each clock cycle, find:

$f_u \times f < 2^n$

8000

(i) The resolution of the ADC.
(ii) The input voltage (v_{in}) if the counter reads 5000 in decimal.
(iii) The ramp down time and digital output value (in decimal) when v_{in} = 8.5V. (4+8)

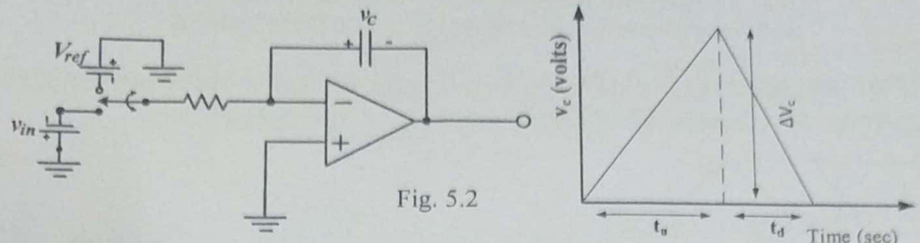

Fig. 5.2

(a) (b)

6. Given the truth table [refer to Table 6.1]:
   (a) Express F_1 and F_2 as product of maxterms.
   (b) Using K-map obtain the simplified functions in 'product-of-sums' form.
   (c) Implement the functions using NAND gates. (1+2+4)

Table 6.1

x	y	z	F_1	F_2
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

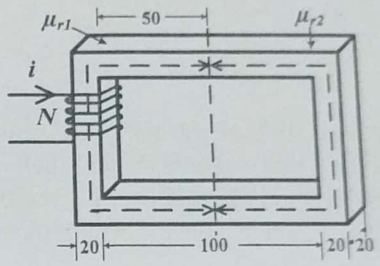

Fig. 8.1

7. (a) What is 'power factor'? Why would the utility impose fine on its customers for poor power factor?
   (b) Assume that the utility imposes a fine on all all households that draw power at a power factor below 0.9. A household draws 2kW active power on an average from a 230V, 50Hz source. If the current drawn is 15A, will this household have to pay a fine to the utility? (2+3)

8. (a) A magnetic system shown in Fig. 8.1 has a core that is made up of two types of magnetic material with μ_{r1} = 2500 and μ_{r2} = 2000. (All dimensions in mm) N = 200 turns
   (i) Draw the equivalent magnetic circuit for the given system.
   (ii) Find the total reluctance of the magnetic circuit.
   (iii) If N=~~1~~200, what is the inductance of the coil?
   (iv) Determine the flux density in the core when the coil current is 2.5A
   (b) Compare an ideal transformer with a practical transformer
   (c) A 50Hz, 10 kVA, 2300/230-V transformer is used to step down the voltage from the transmission line to that of a domestic distribution system. Assuming an ideal transformer, determine the following:
   (i) What load impedance $Z_{L(rated)}$ on the secondary side will cause the transformer to be fully loaded.
   (ii) What is the value of $Z_{L(rated)}$ referred to the high voltage side of the transformer?
   (iii) What is the current in the low voltage winding? (4+2+4)

9. Write short notes on any two: (3 + 3)
   (a) Zener diodes and their applications
   (b) Δ-Y transformation in electrical networks
   (c) Iron losses in transformers