Indian Institute of Technology Patna
Department of Electrical Engineering

EE101 - Electrical Sciences
Autumn - 2015
End Sem Exam
21 November 2015

There are 5 problems. They carry equal marks.

$(5 \times 10 = 50)$

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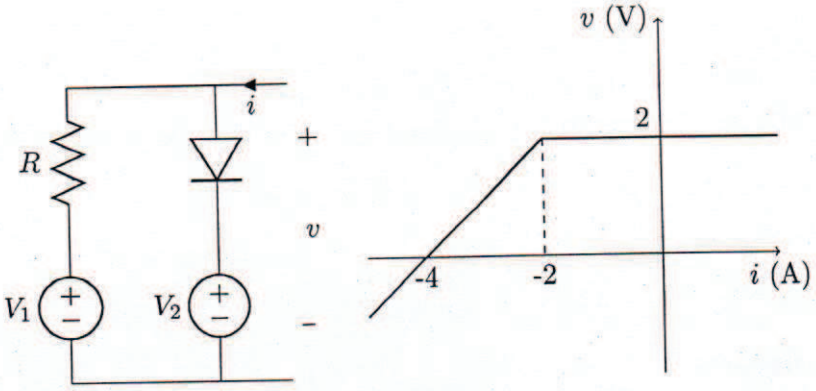
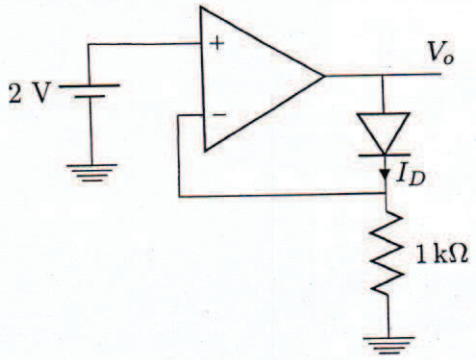
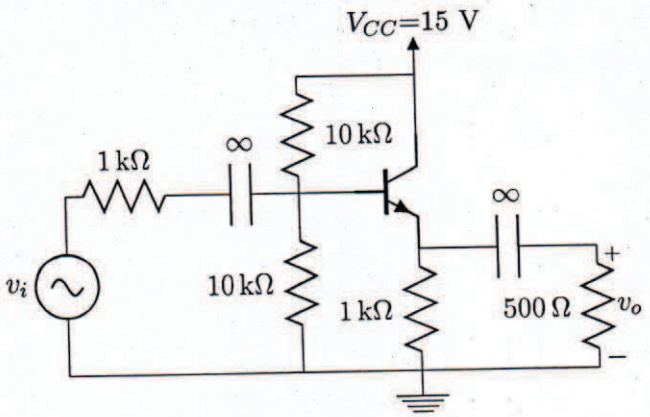
1. (a) Consider the circuit ant its $v - i$ characteristics. Find V_1, V_2 and R.



(b) Consider the circuit. Find V_o and I_D. Use 0.7 V model for diode.

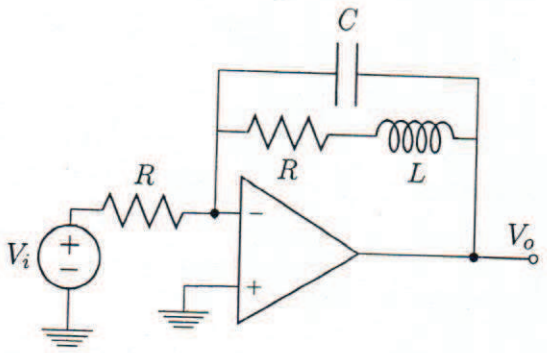


2. Consider the circuit. Assume β =100 and V_{BE}=0.7 V.



(a) Determine the operating point.
(b) Draw the small signal model.
(c) Find the small signal voltage gain.
(d) Find the input and output resistance from the small signal model.

3. Consider the op-amp circuit. Assume that the op-amp is ideal.



(a) Find the differential equation that relates V_o to V_i.

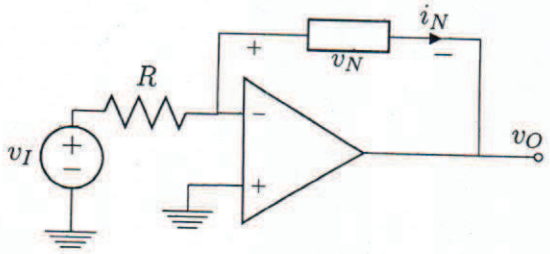
(b) Let $V_i = V_m \cos(\omega t)$. Find the sinusoidal steady state output V_o that has the following form.

$$V_o = A\cos(\omega t + \phi)$$

4. Consider the circuit. The terminal characteristics of nonlinear element is

$$i_N = ae^{bv_N}$$

where a and b are constants.



(a) Find the expression that relates v_O to v_I.

(b) if v_I consists of DC and small signal $(V_I + v_i)$, the output can also be represented as $v_O = V_O + v_o$. Draw the small signal model.

(c) Find the small signal gain expression $\frac{v_o}{v_i}$.

5. (a) Design a three input digital circuit that should give a high output whenever two adjacent bits are high. Implement the circuit using only NAND gates.

(b) Given the truth table for the logic function F:

A	B	C	F
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

i. Write the Product of Sums (POS) expression.

ii. Find the minimum POS expression.

iii. Implement the minimum POS using only NOR gates.