Indian Statistical Institute

Physics III: Electromagnetism & Electrodynamics
May 2004

Time: 3 Hours   Maximum : 60 marks

Instructions: (i) All questions carry equal marks
              (ii) Answer any <u>SIX</u> full questions

1. a) Write down Maxwell's equations for the time varying
        fields both in differential and integral forms.

    b) A conductor carries a steady current of " I " amperes.
        The components of current density vector J are $J_x = 2ax$
        and $J_y = 2ay$. ~~Find the third component~~J_z. (Use the
        equation of continuity to solve this problem). Find $\frac{\partial J_3}{\partial 3}$.

2. a) State the Faraday's Law of electromagnetic induction.

    b) Derive Maxwell's equation connected with Faraday's
        Law

3. a) Using Gauss Law, show that the electric field at a
        point P, located at a normal distance r from a
        uniformly charged infinite plane sheet is propotional
        to the charge/unit area of the sheet.

4. a) An air condenser, consisting of two parallel square
        plates of 50 cm side is charged to a voltage of 200 V
        with plate separation of 1mm. Calculate the work done
        in widening the separation of the plates to 1 cm.

5. a) Two particles having charges 2 nano-coulomb and 5 nano-coulomb are spaced 80 cm apart. Determine the electric field intensity at a point "A" situated at a distance of 0.5 meters from each of the two particles. Assume the medium to be backlite having dielectric constant of 5.

6. a) A single turn circular coil of 50 meter in diameter carries a current of 28×10^4 Amp. Determine the magnetic field intensity H at a point on the axis of coil and 100 meter from the coil. The μ_r of free space is unity.

7. a) What are p-type and n-type semiconductors ?

    b) Write the current-voltage relation for a p-n junction diode.

    c) What are the three different regions of biasing related to the operation of a transistor?

8. a) Show that the transistor circuits a and b given below operates in the active region. Given $\beta = 100$ $I_{CO} = 20$ nA and $V_{BE} = 0.7$ V

(a)   (b)
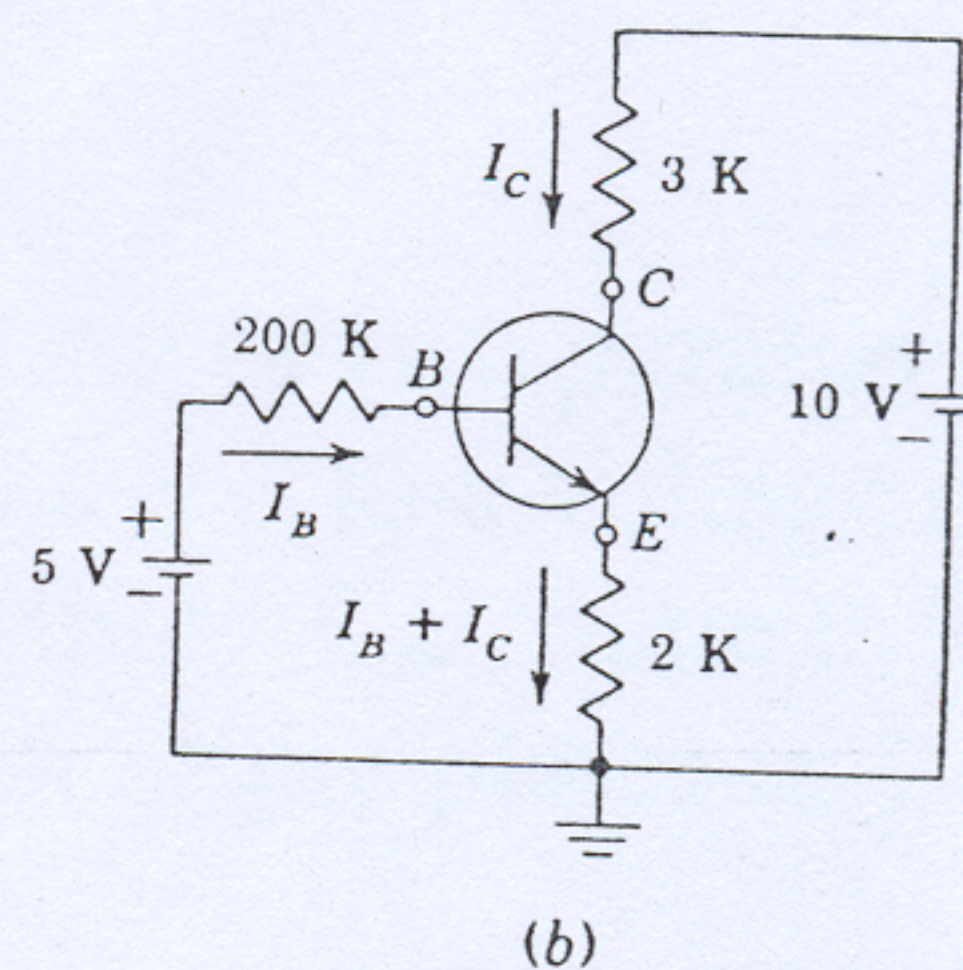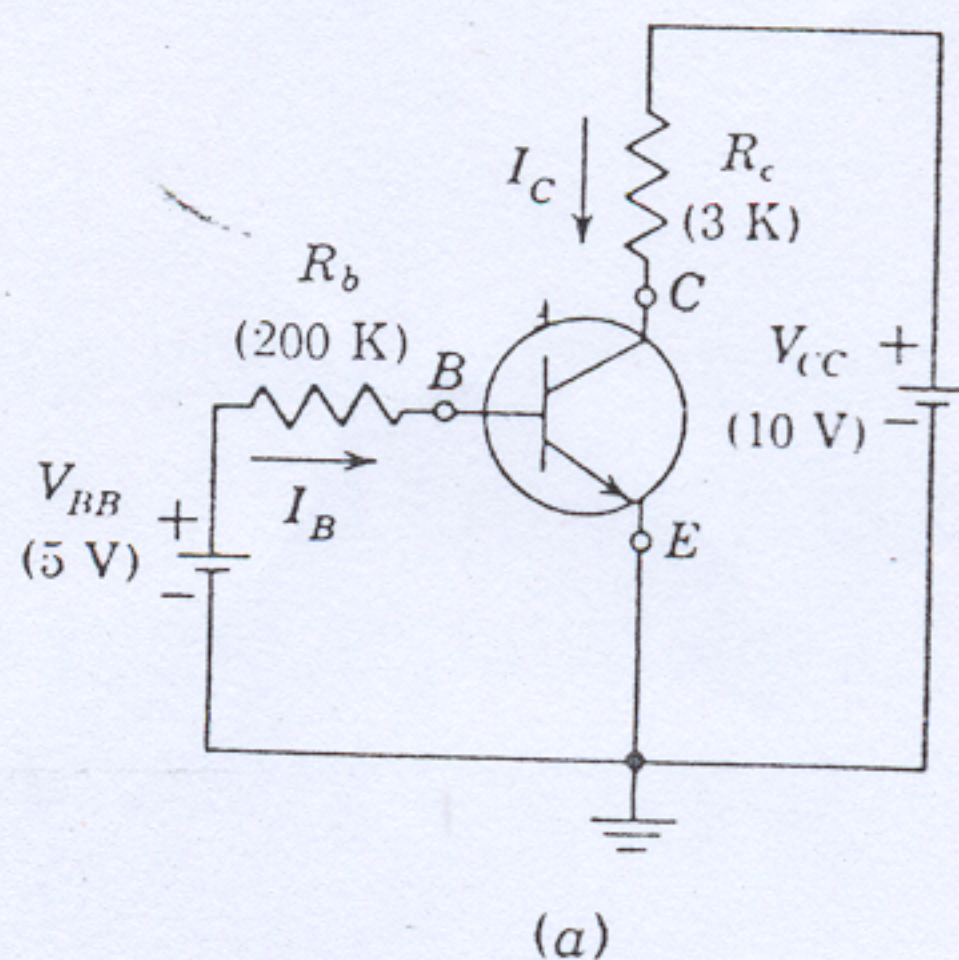
9. a) A common emitter transistor amplifier is shown below. Given $V_{BE} = 0.7V$. Calculate the base voltage V_B, emitter current I_E and collector-emitter voltage V_{CE}.

b) Calculate the a.c. Voltage gain of this circuit for an input signal frequency of 20 Hz.

+12V

R1
10k

Rc
2.2k

Co

Vo

C
10u

Ci

Vi

10u

B

2N2222A

E

R2
1.5k

RE
470

CE
470J