UNIVERSITI SAINS MALAYSIA

Peperiksaan Tambahan
Sidang Akademik 1995/96

Mei/Jun 1996

JEE 132 - Peranti Semikonduktor

Masa : [3 jam]

ARAHAN KEPADA CALON :

Sila pastikan bahawa kertas peperiksaan ini mengandungi 11 muka surat bercetak dan **ENAM (6)** soalan sebelum anda memulakan peperiksaan ini.

Jawab **LIMA (5)** soalan.

Agihan markah bagi soalan diberikan di sut sebelah kanan soalan berkenaan.

Jawab semua soalan di dalam Bahasa Malaysia.

BAHAGIAN A *(SECTION A)*

1. (a) **Pengukuran voltan Hall, V_H, boleh digunakan untuk menentukan jenis semikonduktor ekstrinsik. Jelaskan.**

The measurement of Hall voltage, V_H, can be used to determine the type of extrinsic semiconductor. Explain.

(40%)

(b) **Hubungkan keamatan medan elektrik Hall dengan ketumpatan arus dan keamatan medan magnet.**

Relate electric field intensity with current density and magnetic field intensity.

(30%)

(c) **Tunjukkan bagaimana pengaliran σ dan kebolehgerakan μ boleh ditentukan daripada pengukuran voltan Hall, V_H.**

Show how conductivity σ and mobility μ can be determined from the measurement of Hall voltage V_H.

(30%)

2. (a) **Lukis dan beri penerangan ringkas tentang struktur jalur dalam simpang p-n litar buka.**

Draw and explain briefly the band structure in an open circuit p-n junction.

(50%)

(b) **Apakah nisbah arus bagi satu pincang ke depan 0.05V kepada arus bagi magnitud yang sama tetapi terpincang balikan pada suhu bilik, 300°K ?**

What is the ratio of the current for a forward bias of 0.05V to the current for the same magnitude, reverse bias at room temperature, 300°K?

(20%)

...3/-

(c) **Kirakan nilai voltan yang akan menghasilkan arus balikan dalam simpang p-n diod Germanium bersamaan dengan 90% nilai tepunya pada suhu bilik, 300°K.**

For what voltage will the reverse current in p-n junction germanium diode reach 90% of its saturation value at room temperature, 300°K.

(30%)

3. (a) **Pertimbangkan litar Rajah 3.1. v_1 shingga v_4 adalah masukan dan v_o adalah keluaran litar tersebut. Kirakan v_o apabila voltan masukannya ialah**

Consider the circuit in Figure 3.1. v_1 to v_4 are the inputs and v_o is the output of the circuit. Determine v_o if the inputs are

(i) $v_1 = v_2 = v_3 = v_4 = 0V$

(ii) $v_1 = v_2 = 0$, $v_3 = v_4 = -4V$

(iii) $v_1 = v_2 = -5V$, $v_3 = v_4 = -7V$

(iv) $v_1 = v_2 = v_3 = v_4 = -5V$

Anggap kejatuhan voltan diod ialah 0.6V.

Assume the diod voltage drop is 0.6V.

(30%)

(b) **Pertimbangkan litar Rajah 3.2. v_1 sehingga v_4 adalah masukan dan v_o adalah keluaran litar tersebut. Kirakan v_o apabila voltan masukannya ialah**

Consider the circuit in Figure 3.2. v_1 to v_4 are the inputs and v_o is the output of the circuit. Determine v_o if the inputs are

...4/-

(i) $v_1 = v_2 = v_3 = v_4 = 0V$

(ii) $v_1 = v_2 = 0V$, $v_3 = v_4 = 3V$

(iii) $v_1 = v_2 = 2V$, $v_3 = v_4 = 3V$

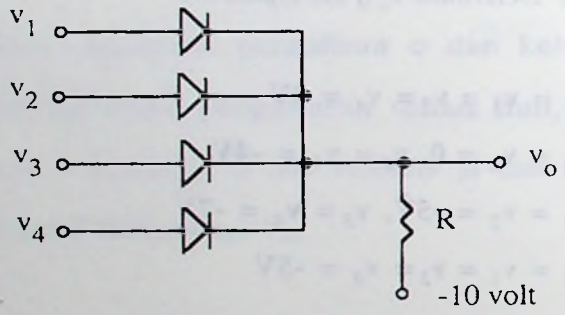
(iv) $v_1 = v_2 = v_3 = v_4 = 3V$

Diod mempunyai kejatuhan voltan seperti diod dalam (a).
Voltage drop of the diod is equivalent to the diodes in (a)

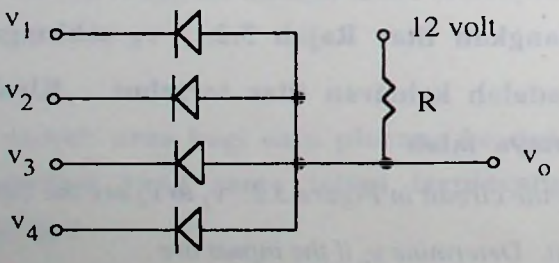
(30%)

(c) **Beri ulasan tentang keputusan daripada (a) dan (b).**
Give comments on the result of (a) and (b).

(10%)



Rajah 3.1 *(Figure 3.1)*



Rajah 3.2 *(Figure 3.2)*

...5/-

(d) **Rujuk Rajah 3.3. Diberikan V_z = 10V, I_{zk} = 3mA dan I_{zm} = 90mA. Anggapkan R_z = 0 dan V_z tetap untuk julat arus tersebut.**

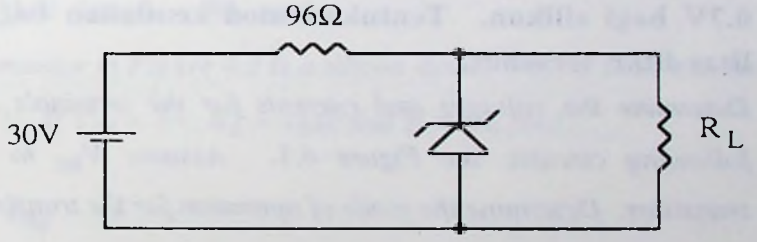
Refer to Figure 3.3. Given V_z = 10V, I_{zk} = 3mA and I_{zm} = 90mA. Assume R_z = 0 and V_z is constant for that current range.

(i) **Tentukan arus beban minimum dan maksimum supaya diod zener akan tetap mengatur.**

Determine minimum and maximum load current so that the diode will maintain its regulation.

(ii) **Apakah nilai R_L minimum dan maksimum.**

Determine R_L minimum and maximum.



Rajah 3.3 *(Figure 3.3)*

(30%)

BAHAGIAN B *(SECTION B)*

4. (a) **Dalam suatu transistor npn, 10^8 lubang/μs bergerak dari tapak ke kawasan pemancar sementara 10^{10} elektrons/μs bergerak dari pemancar ke kawasan tapak. Suatu ammeter memberi bacaan $i_B = 16\mu A$. Tentukan arus pemancar i_E dan arus pengumpul i_C.**

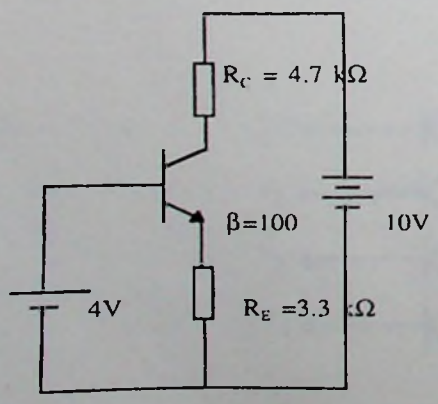
In an npn transistor, 10^8 holes/μs move from the base to the emitter region while 10^{10} electrons/μs move from the emitter to the base region. An ammeter reads the base current as $i_B = 16\mu A$. Determine the emitter current i_E and the collector current i_C.

(20%)

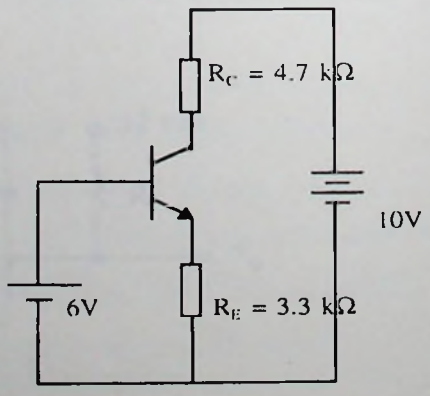
(b) **Tentukan voltan-voltan and arus-arus bagi terminal B, E dan C bagi litar-litar berikut, lihat Rajah 4.1. Anggapkan V_{BE} adalah 0.7V bagi silikon. Tentukan mod kendalian bagi transistor dalam litar-litar tersebut.**

Determine the voltages and currents for the terminals B, E and C for the following circuits, see Figure 4.1. Assume V_{BE} to be 0.7V for silicon transistor. Determine the mode of operation for the transistor in these circuits.

(40%)

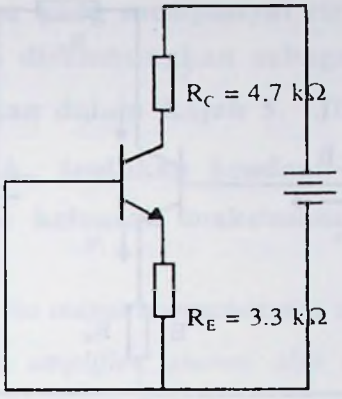


(a)



(b)

...7/-



(c)

Rajah 4.1 *(Figure 4.1)*

(c) **Transistor di dalam Rajah 4.2 adalah peranti silikon yang mempunyai arus tapak 40μA dan I_{CBO} = 0. Jika V_{BB} = 6V, R_E = 1kΩ dan β = 80, cari**

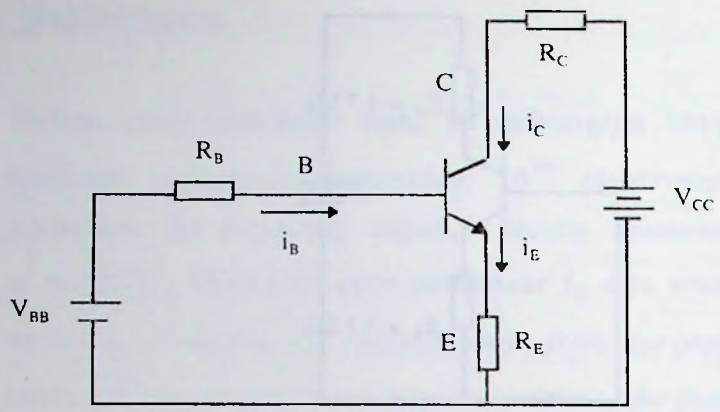
The transistor in Figure 4.2 is a silicon device with a base current of 40μA and I_{CBO} = 0. If V_{BB} = 6V, R_E = 1kΩ and β = 80, find

(i) I_{EQ}

(ii) R_B.

(iii) **Jika V_{CC} = 15V dan R_C = 3kΩ, cari V_{CEQ}.**
If V_{CC} = 15V and R_C = 3kΩ, find V_{CEQ}.

(40%)



Rajah 4.2 *(Figure 4.2)*

5. (a) **Bagi tatasusunan penguat-penguat tapak-sepunya (jenis pnp, Si) dan pemancar sepunya (jenis npn, Si), lakarkan:-**
For the amplifier configuration of common-base (pnp type, Si) and common-emitter (npn type, Si), illustrate:-

(i) **gambarajah skematik bagi litar penguat tersebut**
schematic diagram for the amplifier circuit

(ii) **ciri masukan dengan label-label paksi yang betul**
input characteristics with proper axis labels

(iii) **ciri keluaran dengan label-label paksi yang betul dan nilai arus masukan yang tipikal, serta arus-arus bocor yang wujud.**
output characteristics with proper axis labels and typical input current, also leakage current which are present.

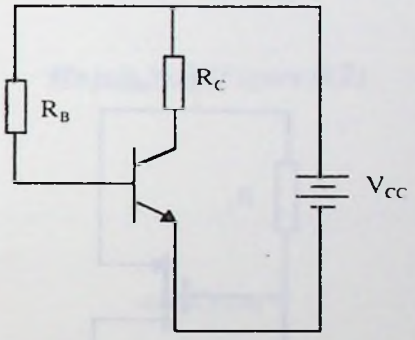
(40%)

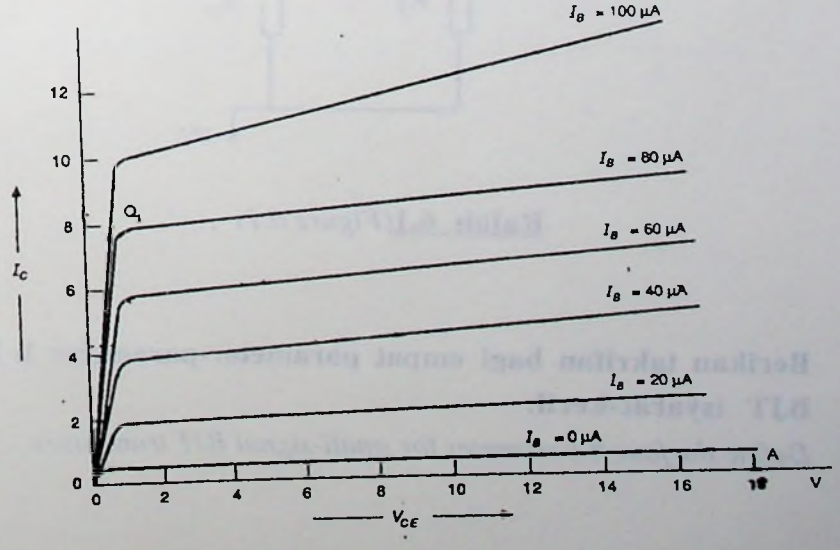
...9/-

(b) **Suatu transistor yang mempunyai ciri keluaran seperti ditunjukkan dalam Rajah 5 disambungkan sebagai penguat pemancar sepunya, juga ditunjukkan dalam Rajah 5. Jika R_C = 2.2kΩ dan V_{CC} = 18V dan I_B = 40μA, tentukan keadaan-keadaan pemincangan peranti dan anggarkan keluaran maksimum yang tidak akan mengalami herotan.**

A transistor with the output characteristics shown in Figure 5 is connected as a common emmiter amplifier, shown also in Figure 5. If R_C = 2.2kΩ and V_{CC} = 18V and I_B = 40μA, determine the device bias conditions and estimate the maximum undistorted output.

(60%)



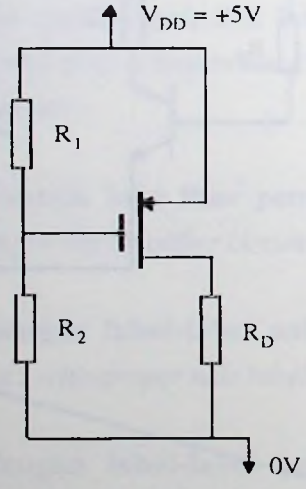


Rajah 5 *(Figure 5)*

...10/-

6. (a) **Rekabentuk litar dalam Rajah 6.1 supaya transistor beroperasi dalam penepuan dengan I_D = 0.5 mA dan V_D = +3V. Biarkan transistor PMOS jenis peninggian mempunyai Vt = -1V dan K = 0.5 mA/V^2. Anggap λ = 0. Apakah nilai terbesar yang mungkin bagi R_D supaya transistor kekal dalam kawasan mod operasi penepuan.**

Design the circuit of Figure 6.1 so that the transistor operates in saturation with I_D = 0.5 mA and V_D = +3V. Let the enhancement-type PMOS transistor have V_t = -1V and K = 0.5 mA/V^2. Assume λ = 0. What is the largest value that R_D can have while maintaining saturation region operation?



Rajah 6.1*(Figure 6.1)*

(50%)

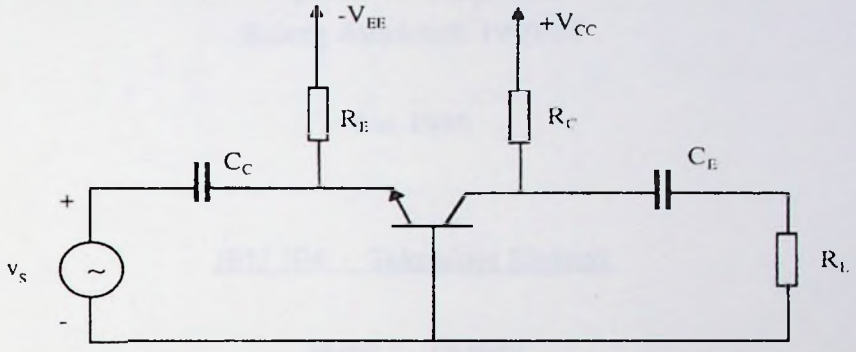
(b) **Berikan takrifan bagi empat parameter-parameter h bagi transistor BJT isyarat-kecil.**

Define the four h-parameter for small-signal BJT transistors.

(20%)

(c) **Tukarkan litar dalam Rajah 6.2 ke dalam bentuk setara h-parameter.**

Transform the circuit in Figure 6.2 into its h-parameter equivalent.



Rajah 6.2 *(Figure 6.2)*

(30%)

-oooOooo -