1. tiha vaja iz VISOKOFREKVENČNE TEHNIKE - 21.10.2016

1. Hitrost delovanja polprevodniških gradnikov je ključno odvisna od mobilnosti nosilcev naboja [cm^2/Vs]. Mobilnost elektronov označimo z μ_n, mobilnost vrzeli pa z μ_p. Sodobni tranzistorji za visoke frekvence so iz polprevodnika GaN, za katerega velja:

(A) $\mu_n << \mu_p$ (B) $\mu_n = \mu_p$ (A) $\mu_n = 0$ (D) $\mu_n >> \mu_p$

2. Dioda 1N4007 je počasna usmerniška PN dioda, dioda 1N5818 pa guard-ring Schottky. Obe sta v enakem ohišju in za obe velja enačba diode $I=I_S.(\exp(U/nU_T)-1)$. Diodi se razlikujeta v naslednjih električnih lastnostih (obkrožite NAPAČEN odgovor):

(A) $I_{S\_Schottky} >> I_{S\_PN}$ (B) $t_{rr\_Schottky} << t_{rr\_PN}$ (C) $U_{T\_Schottky} > U_{T\_PN}$ (D) $n_{Schottky} < n_{PN}$

3. Barvo svetleče diode v glavnem določa širina prepovedanega energijskega pasu polprevodnika. Zeleno svetlečo diodo običajno izdelamo kot PN spoj iz naslednjega polprevodnika:

(A) GaP (B) InP (C) GaN (D) GaAs

4. PIN dioda ima ob pritisnjeni zaporni napetosti kapacitivnost 0.3pF. Kolikokrat se poveča kapacitivnost PIN diode, ko skozi teče tok I=3mA v prevodni smeri? Življenjska doba nosilcev naboja je τ=100ns. V enačbi diode $I=I_S.(\exp(U/nU_T)-1)$ je $n \approx 2$ in $U_T \approx 26mV$.

(A) 200-krat (B) 20000-krat (C) 20-krat (D) 2000-krat

5. Gunn-ov element ali Transferred-Electron Device (ime dioda ni najbolj primerno) pogosto uporabljamo kot negativno upornost v mikrovalovnih oscilatorjih. Gunn-ov element lahko izdelamo iz naslednjega polprevodnika s primernimi energijskimi pasovi:

(A) GaAs (B) Si (C) PbS (D) SiGe

6. Tokovno ojačanje bipolarnega tranzistorja v vezavi s skupno bazo zapišemo $\alpha=I_K/I_E$. Tokovno ojačanje istega tranzistorja v vezavi s skupnim emitorjem zapišemo $\beta=I_K/I_B$. Parametra α in β sta med sabo povezana na naslednji način ($I_E=I_B+I_K$):

(A) $\beta=1-\alpha$ (B) $\beta=\alpha/(1-\alpha)$ (C) $\beta=(1-\alpha)/\alpha$ (D) $\beta=\alpha+1$

7. Ojačevalnik z bipolarnimi tranzistorji ima izhodno stopnjo v razredu B v mirujočem stanju. Ko ojačevalnik krmilimo do nazivne izhodne moči, se povprečna poraba (povprečni tok) izhodne stopnje:

(A) zmanjša (B) ostane enak (C) poveča (D) gre na nič

8. Silicijev NPN tranzistor ima mejno frekvenco f_T=2GHz v vezavi s skupnim emitorjem. Isti tranzistor dosega tokovno ojačanje β_0=150 pri zelo nizkih frekvencah. Kolikšno je tokovno ojačanje tranzistorja β=? pri frekvenci f=100MHz?

(A) 150 (B) 5 (C) 50 (D) 20

9. Sekundarni preboj je najbolj verjeten v silicijevem bipolarnem tranzistorju pod naslednjimi pogoji, v vseh primerih ob enaki moči na čipu P=konst.:

(A) visoka VF napetost (B) visoka DC napetost (C) velik RF tok (D) velik DC tok

10. MOSFET iz silicija ima štiri neodvisne elektrode: vrata G, izvor S, podlago B in ponor D. Silicijev MOSFET je običajno vgrajen v ohišje s tremi električni priključki. Pri tem sta običajno spojeni skupaj dve elektrodi na isti priključek:

(A) S+B (B) G+B (C) G+S (D) D+B

11. N-kanalni MOSFET z induciranim kanalom ima pragovno napetost U_{TH}=+3V. Pri napetosti vrat U_{GS}=+4V doseže tok ponora I_D=1A pri napetosti U_{DS}=+10V. Kolikšen je pričakovani tok ponora I_D'=? pri U_{GS}'=5.5V in isti U_{DS}?

(A) 1.25A (B) 2.50A (C) 6.25A (D) 8.75A

12. GaAlAs/GaAs HEMT z vgrajenim kanalom je odličen visokofrekvenčni ojačevalnik. Pri uporabi moramo paziti, da skozi vrata ne steče prevelik tok in ne poškoduje kanala. Katere od navedenih napetosti U_{GS} NE smemo priključiti na vrata HEMT?

(A) -1.5V (B) -0.3V (C) +0.3V (D) +1.5V

Priimek in ime: Elektronski naslov:

1st midterm exam HIGH-FREQUENCY TECHNOLOGY - 21.10.2016

1. The operating speed of semiconductor devices critically depends on the charge-carrier mobility [cm^2/Vs]. Let μ_n denote the electron mobility and μ_p. denote the hole mobility. Modern high-frequency transistors are made of GaN, where the following holds:

(A) $\mu_n << \mu_p$ (B) $\mu_n = \mu_p$ (A) $\mu_n = 0$ (D) $\mu_n >> \mu_p$

2. The diode 1N4007 is a slow PN rectifier while the 1N5818 is a guard-ring Schottky. Both come in the same package and the diode equation $I=I_S.(\exp(U/nU_T)-1)$ holds for both. The diodes differ in the following properties (circle the WRONG answer):

(A) $I_{S\_Schottky} >> I_{S\_PN}$ (B) $t_{rr\_Schottky} << t_{rr\_PN}$ (C) $U_{T\_Schottky} > U_{T\_PN}$ (D) $n_{Schottky} < n_{PN}$

3. The color of a light-emitting diode is mainly defined by the energy bandgap of the semiconductor material. A green light-emitting diode is usually manufactured as a PN junction from the following material:

(A) GaP (B) InP (C) GaN (D) GaAs

4. At reverse bias, a PIN diode has a capacitance of 0.3pF. How many times the capacitance increases at a forward current of I=3mA? The minority-carrier lifetime is τ=100ns. In the diode equation $I=I_S.(\exp(U/nU_T)-1)$ the constants are $n \approx 2$ and $U_T \approx 26mV$.

(A) 200-times (B) 20000-times (C) 20-times (D) 2000-times

5. A Gunn element or Transferred-Electron Device (the name diode is not appropriate) is frequently used as a negative resistance in microwave oscillators. A Gunn element can be manufactured from the following semiconductor with appropriate energy bands:

(A) GaAs (B) Si (C) PbS (D) SiGe

6. The current gain of a bipolar transistor in a common-base configuration is $\alpha = I_K/I_E$. The current gain of the same transistor in a common-emitter configuration is $\beta = I_K/I_B$. The parameters α and β are related in the following way ($I_E = I_B + I_K$):

(A) $\beta = 1-\alpha$ (B) $\beta = \alpha/(1-\alpha)$ (C) $\beta = (1-\alpha)/\alpha$ (D) $\beta = \alpha+1$

7. A bipolar-transistor amplifier has the output stage biased for class B operation in the quiescent state. When the amplifier is driven to produce its rated output power, the average current drain of its output stage:

(A) decreases (B) stays the same (C) increases (D) goes to zero

8. A silicon NPN transistor has its common-emitter transition frequency f_T=2GHz. At very low frequencies its current gain rises up to β_0=150. What is the transistor current gain β=? at a frequency of f=100MHz?

(A) 150 (B) 5 (C) 50 (D) 20

9. A secondary breakdown is most likely to happen in a silicon bipolar transistor under the following conditions, all of them at the same dissipated power P=const.:

(A) high RF voltage (B) high DC voltage (C) high RF current (D) high DC current

10. A silicon MOSFET has four independent electrodes: gate G, source S, drain D and substrate B (Bulk). A silicon MOSFET is usually available in a package with three terminals only. The following two electrodes are connected to a single terminal:

(A) S+B (B) G+B (C) G+S (D) D+B

11. A N-channel enhancement MOSFET has a gate threshold voltage U_{TH}=+3V. At a gate voltage U_{GS}=+4V, the drain current reaches I_D=1A at an U_{DS}=+10V. What is the expected drain current I_D'=? at U_{GS}'=5.5V and same U_{DS}?

(A) 1.25A (B) 2.50A (C) 6.25A (D) 8.75A

12. A depletion-mode GaAlAs/GaAs HEMT is an excellent high-frequency amplifier. The gate current should be limited to avoid damaging the channel. Which gate voltage U_{GS} should NOT be applied to the gate of the HEMT?

(A) -1.5V (B) -0.3V (C) +0.3V (D) +1.5V

Name: Email: