UNIVERSITY OF GHANA
SECOND SEMESTER EXAMINATIONS, 2013/2014
LEVEL 300: BACHELOR OF SCIENCE IN ENGINEERING
CPEN 306: MICROELECTRONICS DEVICES AND CIRCUITS

INSTRUCTIONS: Answer **ALL five (5)** questions.
Time Allowed: ***THREE (3)*** *hours*

Q1. (a) Draw a single stage common emitter amplifier using a voltage divider biasing network. **[4 marks]**

(b) Given that the voltage divider network is formed by resistors $\mathbf{R_1}$ and $\mathbf{R_2}$, and that the values of $\mathbf{R_1 = 20k\Omega}$ and $\mathbf{R_2 = 40k\Omega}$. If the power supply $\mathbf{V_{cc} = 10V}$ and the load resistor is $\mathbf{12k\Omega}$ whilst the resistor connected to the emitter is $\mathbf{10k\Omega}$, calculate the:

(i) quiescent base voltage.
(ii) quiescent base current.
(iii) required capacitance of the capacitor needed at the emitter terminal to ensure d.c stabilization if the signal frequency ranges from **100Hz** to **20kHz**. **[12 marks]**

(c) Explain why the potential divider bias network is mostly preferred to other biasing arrangement. **[2 marks]**

(d) Explain the term **-3dB** bandwidth as applied to amplifiers. **[2 marks]**

Q2. Define the following parameters of power supply systems:

(a) (i) Efficiency of rectification. **[2 marks]**
(ii) Ripple factor. **[2 marks]**
(iii)Peak inverse voltage (PIV). **[2 marks]**

(b) A single-phase full-wave rectifier uses a power transformer whose secondary voltage is **220V r.m.s**. The load resistor is $\mathbf{25k\Omega}$. Neglect the transformer losses and the forward drops in the diodes. Determine the following:
(i) d.c output voltage. **[4 marks]**
(ii) ripple voltage. **[4 marks]**
(iii) PIV. **[4 marks]**

(c) What is the distinct advantage of bridge rectifier circuit over the normal full-wave rectifier circuit? **[2 marks]**

Q3. (a) Draw the small signal **h-parameter** equivalent of a common-emitter amplifier circuit. **[3marks]**

(b) A common-emitter amplifier has the following **h-parameters**:

$\mathbf{h_{fe} = 100}$; $\mathbf{h_{oe} = 200\mu S}$; $\mathbf{h_{re} = 160 \times 10^{-6}}$; $\mathbf{R_L = 24k\Omega}$,

Calculate the following:

(i) Current gain, $\mathbf{A_i}$. **[2marks]**

(ii) Input resistance, $\mathbf{r_{ie}}$. **[2marks]**

(iii) Voltage gain, $\mathbf{A_r}$. **[2marks]**

(c) With the aid of a circuit diagram, explain how a transistor can be used as an electronic switch. **[5 marks]**

(d) A switching NPN silicon transistor has a forward current gain, $\beta = 100$ and maximum collector current, $I_{MAX} = 10mA$. If the input voltage is **12V**, calculate the base resistor needed to switch the load "fully ON". **[6 marks]**

Q4. (a) A **6V** d.c stabilized power supply needed to operate a computer is to be produced from a **15V** full-wave bridge rectifier using a Zener diode as the regulator circuit. The maximum power rating of the Zener diode, P_Z is **4W**. Calculate the following:

(i) maximum current flowing through the Zener diode. **[3marks]**

(ii) value of the series current limiting resistor, R_S. **[3 marks]**

(iii) load current, I_C if a load resistor of **2kΩ** is connected across the Zener diode. **[3 marks]**

(iv) total supply current, I_S. **[3 marks]**

(b) Give **three (3)** advantages of **CMOS ICs** over other types of **ICs**. **[3 marks]**

(c) What is the main difference between Depletion-type MOSFETs and the Enhancement-type MOSFETs? **[3 marks]**

(d) Explain the Zener breakdown phenomenon associated with semiconductor diodes when the reserve bias voltage applied across them are increased beyond the breakdown point. **[2marks]**

Q5. (a) Draw a circuit diagram of a single-stage n-channel FET amplifier and explain the effects of negative gate voltage and positive drain voltage on drain current. **[6marks]**

(b) Define the FET parameter transconductance (g_m). **[2marks]**

(c) Draw a frequency response curve of a resistance-capacitance coupled amplifier and explain the causes of the sudden drop in amplification at the low and high frequency ranges. **[6marks]**

(d) Determine the voltage and power gain in decibel (**dB**) of an amplifier with an input signal of **1mA** at **10mV** and corresponding output signal of **10mA** at **1V**. **[6marks]**