UNIVERSITY OF ESWATINI

FACULTY OF SCIENCE AND ENGINEERING

DEPARTMENT OF PHYSICS

SUPPLEMENTARY EXAMINATION, JANUARY 2019

TITLE OF PAPER	:	ELECTRONICS 1
COURSE NUMBER	:	PHY 311
TIME ALLOWED	:	THREE HOURS
INSTRUCTIONS	:	Answer **FOUR** (4) questions only.
	:	Each Question carries **25 Marks**
	:	Marks for different Sections are shown in far Right margin.

THIS PAPER HAS 6 PAGES, INCLUDING THIS ONE.

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1. (a) Sketch the charge density (ρ), electric field (E), and electric potential (V) of a pn-junction. **[3]**

(b) Describe the steps you would undertake to determine the conduction state of an ideal diode? **[4]**

(c)The following table is based on the characteristics of a junction field effect transistor.

V_{GS} (V)	-5	-4	-3	-2	-1
I_D (mA)	0.8	0.2	3.5	5.5	7.3

(i) Which type of field effect transistor can be represented by the data in the table above? **[1]**

(ii) Draw a graph using this data. **[3]**

(d) Draw a simple common-source amplifier, with $V_{DD} = 24V$, $R_D = 2k\Omega$ and the source resistance $R_S = 390\Omega$. The gate should be effectively at zero potential. **[4]**

(e) With reference to the circuit and graph in (a) and (b) above, determine the quiescent values of I_D and V_{DS} and when the operating point corresponds to $V_{GS} = -2\ V$. **[6]**

(f) Determine the voltage amplification of the amplifier. **[4]**

2. (a) Sketch the I-V characteristics of a npn-transistor, indicating the operating regimes. [6]

(b) Briefly explain the operating regions mentioned in (a) above. [4]

(c) Define the hybrid parameters of npn transistor in terms of the d.c. currents and voltages . [4]

(d) Describe how you would determine the hybrid parameters of a bipolar transistor from the input and output characteristics of the transistor. [6]

(e) Draw the small-signal equivalent circuit of a bipolar transistor containing a current-dependent voltage source. [2]

(f) A bipolar transistor with a forward current gain $\beta = 100$ passes a collector current of 26mA. Estimate the input resistance of the transistor. [3]

3. (a) With the aid a circuit diagram, explain how a full-wave rectifier that utilises a center-tapped transformer operates. Sketch the output of the rectifier with reference to the secondary voltage of the transformer. [6]

(b) A common-emitter stage is based on an npn transistor with the following parameters; $h_{ie} = 4\ k\Omega$, $h_{re} = 10^{-4}$, $h_{fe} = 200$, $h_{oe} = 2.0x10^{-5}\Omega^{-1}$
The load resistor has a value of 1 kΩ. With the aid of small signal equivalent circuit, derive the expressions and then calculate the values of each of the following

(i) the current gain [6]

(ii) the input impedance [5]

(iii) the voltage gain [6]

(iv) the power gain [2]

4. (a) Consider the circuit of the basic common-emitter amplifier shown in Figure 1.

   (i) State the uses of C_1 and C_E. [2]

   (ii) Why are the resistors R_1 and R_2 included in the circuit? [1]

   (b) In Figure 1 $V_{CC} = 12V$, $I_C = 2mA$, and $V_{BE} = 0.65V$.

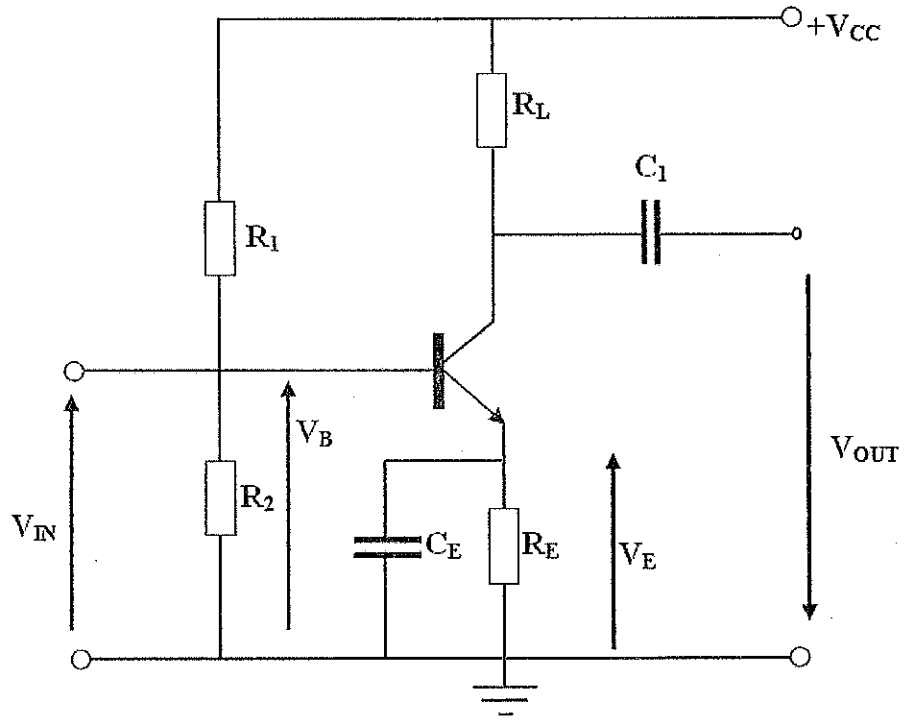

Figure 1: Common Emitter Amplifier

   (i) Calculate R_E when $1/10th$ of the supply voltage appears across it. [4]

   (ii) Calculate R_L when $V_{CE} = V_{CC}/2$. [4]

   (iii) Calculate I_B given that $\beta = 100$, [2]

   (iv) Determine the value of R_2 when $I_{R_2} = 10I_B$. [4]

   (c) A Zener diode stabilizing circuit has an input voltage of 18 V and a diode current of 8 mA to give 10 V across a load resistor of 1200 Ω. Calculate

   (i) the value of the series resistor. [5]

   (ii) the diode current when the load resistor is 1000 Ω. [3]

5. (a) Sketch the structure and circuit symbol of an n-channel JFET. [2]

(b) Draw the output characteristics of of an n-channel JFET and indicate the operating regions. [4]

(c) Describe briefly the dynamics of operation in the regions mentioned in (b). [3]

(d) If the drain current I_D is a function of V_{DS} and V_{GS}, derive the small-signal equation for I_D and draw the small-signal equivalent circuits for n-channel JFETs in terms of voltage dependent voltage source. [5]

(e) Consider the N-channel MOSFET amplifier given in Figure 2 below. $I_{DS} = \frac{K}{2}(V_{GS} - V_T)^2$, $V_{DD} = 5V$, $R_L = 2\ k\Omega$, $K = 1\ mA/V^2$, and $V_T = 1V$. You can ignore the r_d of the MOSFET. C_C is the input coupling capacitor and you can assume it is infinitely large.

(i) Write an expression for the transistor bias point V_{GSQ} as a funtion of V_{DD}, R_a and R_b. [1]

(ii) Determine the required ratio R_a/R_b such that the MOSFET transconductance $g_m = 1\ mA/V$. [5]

(iii) What is the voltage bias point of the output V_{outQ}? [3]

(iv) Draw the small-signal model for the amplifier. [2]

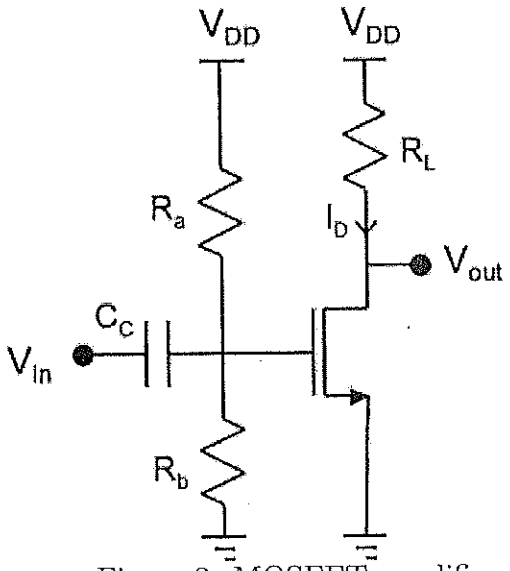

Figure 2: MOSFET amplifier

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