MACHAKOS UNIVERSITY

University Examinations 2017/2018

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERINGB

FIFTH YEAR SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE (ELECTRICAL AND ELECTRONIC ENGINEERING)

EEE 519: RADIO FREQUENCY CIRCUIT DESIGN

DATE: 14/12/2017 **TIME: 8.30-10.30 AM**

INSTRUCTIONS:

(i) There are a total of **Five** questions.
(ii) Question No. 1 is **Compulsory** and carries **30 Marks**.
(iii) Select any **other Two** questions, each of which carries 20 Marks.
(iv) Define all symbols used.
(v) Marks will be awarded for procedure, methodologies used and not necessarily the final answer.

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1. (a) (i) Using relevant schematic diagrams, demonstrate the operations of an oscillator. (4 Marks)

(ii) Fig. Q1 is an amplifier with the Transistor connected in Common Base configuration. Derive the T-Model equivalent circuit of the circuit. (6 Marks)

(b) (i) Using symbols of various types, demonstrate thorough understanding of MOSFETs. (4 Marks)

(ii) Determine the radius of the AWG 26 wire if the diameter of the AWG 44 wire is 1.0 *mils* (2.54×10^{-3} m). (6 Marks)

(c) (i) Using relevant schematic diagrams show why Schottky diodes are preferredfor *RF* circuits. (4 Marks)

(ii) Outline the role of the crystal in the Crystal Oscillator circuit.

(6 Marks)

2. (a) (1) Compute the skin depth for:-
(a) Copper (σ_{cu} = 64.516 X 10^6 S/m) at:-
a. 1GHz . (5 Marks)
b. 10GHz. (5 Marks)

(2) Find the resistance of a 10*cm* long, with 1*mm* diameter
a. Copper wire (5 Marks)
b. Aluminium wire (σ_{Al} = 40 X 10^7 S/m) (5 Marks)

3. Consider a Transmission Line with λ = 1.5 metres, Z_o = 400 Ω, Z_R = 125 + j60. The Line is to be matched using a Single Stub Tuner.

(i) Show why matching is necessary in a Transmission Line. (4 Marks)
(ii) Using a Smith Chart, determine:-
a. The appropriate location of the Stub Tuner from the Load. (8 Marks)
b. The Length of the Stub. (8 Marks)

4. (a) Fig. Q4 gives the Characteristics of a MOSFET, *Tr*, whose *Q* point is at V_{GS} = -10V, V_{BS} = +4V, V_{DS} = -10V. Determine the Drain Current for Tr when:-
(i) V_{BS} = 0V. (2 Marks)
(ii) V_{BS} = +4V. (2 Marks)
(iii) V_{BS} = +10V (2 Marks)

(b) Calculate the Mutual Conductance (g_m) for *Tr* at:-

(i) V_{BS} = 0V. (2 Marks)
(ii) V_{BS} = +4V. (2 Marks)
(iii) V_{BS} = +10V (2 Marks)

(c) Draw a plot of g_m versus V_{BS} and give its interpretation. (4 Marks)
(d) Draw the equivalent circuit of the MOSFET. (4 Marks)

5. (a) Using relevant schematic diagrams:-
c. Show how a crystal oscillator operates (8 Marks)
d. Identify the design considerations. (4 Marks)

(b) Consider a Two-Port Network [S].

(i) Derive the *S* parameters for the Network. (4 Marks)

(ii) Demonstrate thorough understanding of what the *S* parameters actually mean in the *RF* field. (4 Marks)

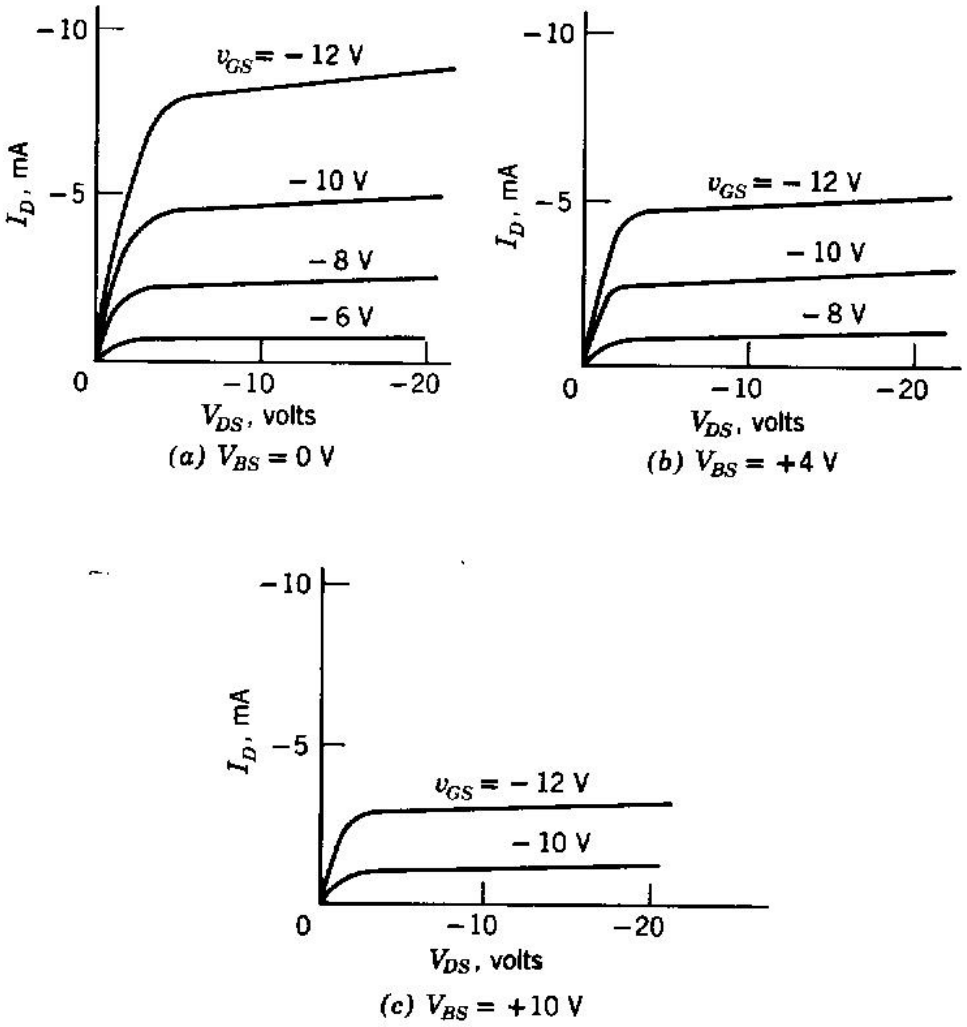
−10
−5
0
−10
−20
I_D, mA
V_{DS}, volts
v_{GS} = − 12 V
− 10 V
− 8 V
− 6 V
(a) V_{BS} = 0 V
(b) V_{BS} = +4 V
(c) V_{BS} = +10 V

Fig. Q4