Bengal Engineering and Science University
Final -Sem Examination 2013-May.
2nd Sem M.E. E&T.C.
Subject: RF IC RF MEM (ETC-1035)

FM - 35

FIRST HALF

Answer question 1 and any two from the rest.

1. a) Discuss the main challenges in RF IC design.
   b) For square-law MOS transistors operating in saturation, the characteristic of the figure below can be express as [Ref. Fig. 1]

$$V_{out} = \frac{1}{2}\mu_n C_{ox}\frac{W}{L}V_{in}\sqrt{\frac{4I_{SS}}{\mu_n C_{ox}\frac{W}{L}} - V_{in}^2 R_D}$$

If the differential input is small, approximate the characteristic by a polynomial.

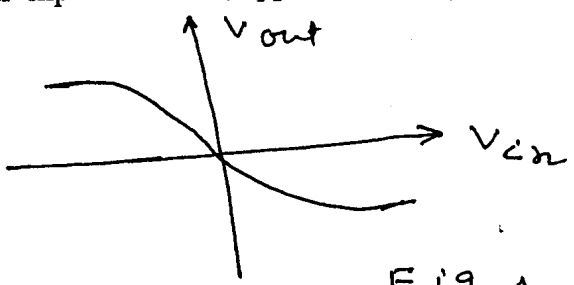


Fig. 1

c) Two nonlinear stages are cascades. If the input / output characteristic of each stage is approximated by a third order polynomial, determine the P_{1dB} of the cascade in terms of the P_{1dB} of each stage

d) An analog multiplier mixes its two inputs as shown in the figure below, ideally producing $y(t) = kx_1(t) \cdot x_2(t)$, where k is a constant. Assume $x_1(t) = A_1 \cos w_1 t$ and $x_2(t) = A_2 \cos w_2 t$.

(i) If the mixer is ideal, determine the output frequency components.

(ii) If the input port sensing $x_2(t)$ suffers from third order non linearity, determine the output frequency components.

(13)

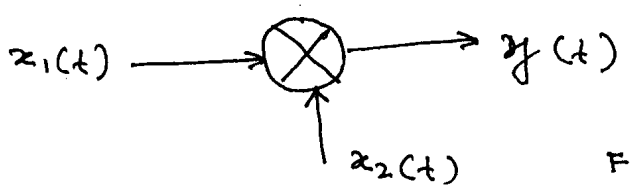


Fig. 2

2. a) A 900 MHZ GSM transmitter delivers a power of 1 W to the antenna. By how much must the second harmonic of the signal be suppressed so that it does not desensitized a 1.8 GHz receiver having P_{1dB}

= -25 dBm? Assume the receiver is 1 m away and the 1.8 GHz signal is attenuated by 10 dB as it propagates across this distance.

b) Explain cross modulation and inter modulation. Also discuss the differences between that terms.

c) Explain third intercept point (11)

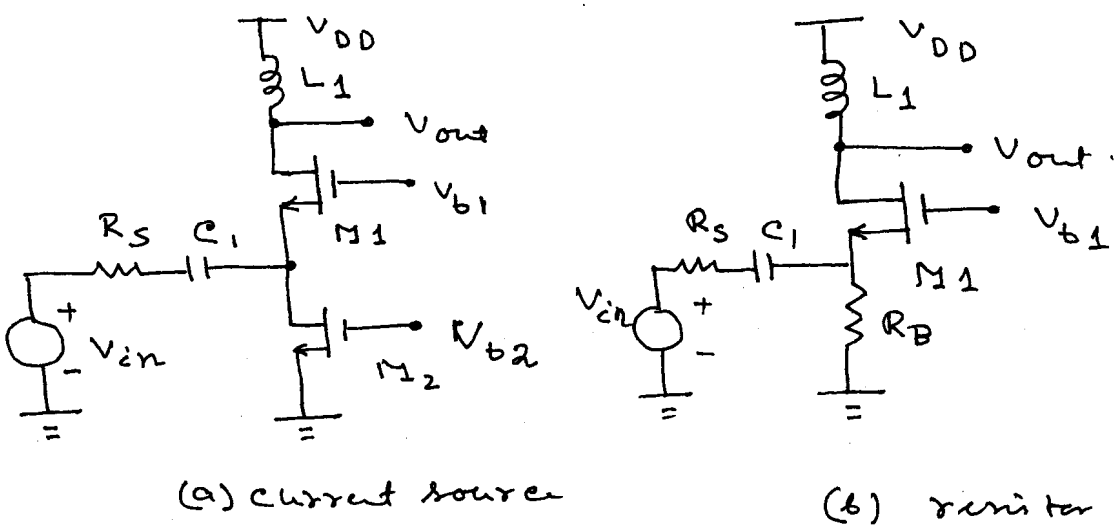
3. a) Draw the diagram of three turn spiral inductor and calculate the inductor metal area in terms of the other geometric properties.

b) Prove that for an N-turn spiral inductor, the equivalent inter winding capacitance is given by

$$C_{tot} = \frac{C_1 + \ldots\ldots + C_{N^2-1}}{(N^2-1)^2}$$ (11)

We wish

4.a) To provide bias current of the common gate stage by a current source or a resistor (Fig. 3). Compare the additional noise in these two cases.



b) " Input impedance of the CS stage is too low if channel length modulation is neglected and too high if it is not! " - Discuss the statement.

c) "Input impedance of an amplifier at very high frequency can be lowered by CS cascode stage." With necessary circuit diagram explain that statement. (11)

5. Write short notes on
   (i) Noise figure
   (ii) Loss mechanism of an inductor.
   (iii) Inductor modeling. (11)

M.E. Electronics and Telecommunication 2nd Semester Examination, 2013

RF IC and RF MEMS (ETC 1035)

Second half

Marks: 35

Answer any three questions

2 marks are reserved for neatness

1a) Why MEMS based capacitors and inductors are required in RF circuits?
b) What is pinch-off voltage in MEMS capacitor and explain its significance? Derive the expression for the same.

(4+7)

2a) Discuss a circuit configuration to increase the variation of capacitance with applied voltage in a two plate MEMS capacitor. Derive the expression of the pull down voltage in this configuration.
b) How a three plate MEMS capacitor design is used to increase the tunability of capacitance with applied voltage?

(6+5)

3a) What are the factors on which the dynamic response of a MEMS capacitor depend? How the capacitor should be connected with the RF circuit so that it can operate properly in the presence of high frequency voltage signals?
b) For the design of a two plate MEMS capacitor, if the actual deformation of a 2D plate has to be considered, discuss a methodology to obtain the changed value of the capacitance after deformation.

(5+6)

4a) Explain how a levering structure can be used in a parallel plate MEMS capacitor to obtain a large tuning ratio?
b) Derive the approximate expression for capacitance and pull down voltage considering surface roughness of hemispherical shape in a two plate MEMS capacitor.

(4+7)

5) Show the process flowchart for
i) Fabrication of a surface micromachined two plate MEMS capacitor
ii) Fabrication of high-Q MEMS inductor

(6+5)