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M. TECH. DEGREE EXAMINATION

Model Question Paper

First Semester

Specialization: Applied Electronics

MECAE 102 ANALOG INTEGRATED CIRCUIT DESIGN

(Regular - 2013 Admissions)

Time: Three Hours Maximum: 100 Marks

Answer **all** *questions.*
Each question carries 25 marks.

1. (a) Show that MOSFET acts as a controlled resistor in deep triode region. (5 marks)

   (b) Discuss the various short channel effects in MOS devices. (8 marks)

   (c) Describe how substrate doping, oxide thickness, surface charge density, and source - substrate bias affect the gate - source voltage at which the channel of a MOSFET becomes conductive. (12 marks)

Or

2. (a) Briefly explain the second order effects in MOSFETs. (5 marks)

   (b) Discuss the temperature dependence of saturation drain current in MOSFETs. (8 marks)

   (c) Describe a complete small-signal model of a MOSFET which can be used at high frequencies and hence prove that the frequency at which the small-signal current gain drops to unity is: $f_T = \frac{\mu_n}{2\pi}\frac{V_{GS} - V_{TH}}{L^2}$. (12 marks)

3. (a) Derive the expression for the impedance of a diode-connected MOSFET. (5 marks)

   (b) Discuss about the large-signal behavior of a common-gate amplifier. (8 marks)

   (c) Describe the working of a cascode amplifier with necessary derivations and hence explain how cascoding is beneficial than increasing the channel length of a MOSFET, for increasing the voltage gain. (12 marks)

Or

4. (a) Draw the noise model of a source follower with necessary equations. (5 marks)

   (b) Discuss how the effect of channel length modulation is suppressed in a cascode current mirror. (8 marks)

   (c) Describe the frequency response of a common source amplifier with necessary equivalent circuits and hence calculate the input impedance and output impedance of the amplifier. (12 marks)

5. (a) Write a short note on CMRR of differential amplifiers. (5 marks)

(b) Discuss about the common-mode response of differential amplifiers. (8 marks)

(c) Describe how the small-signal voltage gain of a differential amplifier can be computed by applying: (i) principle of superposition, and (ii) concepts of virtual ground and half circuit. (12marks)

Or

6. (a) Sketch and explain the working of a differential amplifier with passive load. (5 marks)

(b) Discuss the high-frequency behavior of a differential pair with active current mirror. (8 marks)

(c) Describe the circuit of a differential pair including the input-referred noise sources and hence estimate the input-referred noise, by modeling the noise sources as: (i) voltage sources, and (ii) current sources. (12 marks)

7. (a). List the characteristics of ideal operational amplifier. (5 marks)

(b) Discuss the concepts of gain and phase margins with respect to stability. (8 marks)

(c) Describe the small-signal equivalent circuit of a single stage MOS op-amp configured as a unity gain buffer and hence determine the input common mode voltage and output impedance for this buffer. (12 marks)

Or

8. (a) What limitations of one-stage op-amps are overcome in two-stage op-amps? (5 marks)

(b) Discuss the operation of op-amps with current mirror load. (8 marks)

(c) Describe the operation of two-stage op-amps with balanced and unbalanced outputs and explain the methods by which the output impedance can be increased without adding more cascade devices. (12 marks)