INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY
THIRUVANANTHAPURAM, 695 547

B.Tech ECE – Midterm – September 2024

AV 412 – Satellite and Optical Communication

Time: 2 hour Date: 24/09/2023 Max. Marks: 30

Note: Write Part A and Part B in separate sheet

PART - A - Satellite Communication

Answer the following

1. Design an $(n, k) = (5, 2)$ linear block code.
   (a) Calculate the generator matrix for the codeword set and the parity-check matrix with the goal of maximizing d_{min}.[2]
   (b) What are the error-correcting and error-detecting capabilities of the code? Justify your answer. [1]
   (c) Make a syndrome table for the correctable error patterns [2]
2. Calculate the improvement in probability of message error relative to an uncoded transmission for a (24, 12) double-error-correcting linear block code. Assume that coherent BPSK modulation is used and that the received Eb /N0 = 10 dB.[4]

Table 5.2 Short table of Q(z) values

z	Q(z)
0	0.5
2.0	2.28 E-2
3.0	1.35 E-3
4.0	3.17 E-5
4.7	1.30 E-6
5.0	2.87 E-7
6.0	1.00 E-9
7.0	1.28 E-12
8.0	6.22 E-16

3. Explain the term shannon limit. [2]
4. Explain what is meant by coding gain as applied to error correcting (EC) coding. When EC coding is used on a digital link, a coding gain of 3 dB is achieved for the same BER as the uncoded case. What decibel reduction in transmitted carrier power does this imply? [2]
5. The bit rate for a baseband signal is 1.544 Mb/s, and EC at a code rate of 7/8 is applied before the signal is used to modulate the carrier. Given that the system uses raised-cosine filtering with a rolloff factor of 0.2, determine the bandwidth required for (a) BPSK, and (b) QPSK. [2]

PART - B - Optical Communication

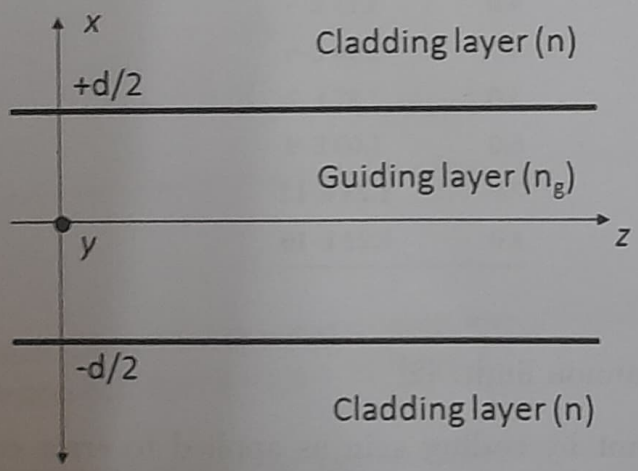
Answer the following

6. Consider a planar dielectric waveguide whose substrate has a refractive index (RI) of 1.56, guiding layer of RI=1.6 and free space as its cover material. Calculate the minimum angle with respect to the normal with which a ray of light can be incident at the guide-cover or guide-substrate interface so that it still remains confined to the guiding layer and can undergo total internal reflection. [2]

7. An optical fiber of core refractive index n1 and cladding index n2 is placed in a medium whose index is given by n. For this arrangement, obtain an expression for the maximum acceptance angle so that light launched can undergo total internal reflection. For this arrangement, define what numerical aperture is. [2]

8. Qualitatively draw the ray picture and wave picture for the fundamental and first order mode inside a symmetrical waveguide. Explain the figure what you have drawn. Your explanation should also consider leakage to the cladding. (hint: consider Goos-Hanchen shift while drawing the ray picture) [4]

9. For a symmetric dielectric slab waveguide shown below, derive the eigenvalue equation for the symmetric TE mode. The index of guiding region is ng (-d/2¡x¡d/2), and the index of cladding is n. (Points will be awarded only if every step is logically illustrated and all assumptions made and properly justified.) [5]



10. Obtain an expression for the multi-path time dispersion in optical fibers. Explain how can you minimize this dispersion? [2]

INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY
THIRUVANANTHAPURAM, 695 547
B. Tech Seventh Semester ECE - Mid Term- September 2024
AV411 - Navigation Systems and Sensors
Time: Two Hours Date: 23/09/2024 Max. Marks: 30

Read **ALL** the instructions in this **NOTE**. Write your name and ID number on Answer Papers. Do **NOT** panic. Answer **ALL** questions. All the steps must be stated clearly. The steps carry more marks than the final answer. Provide illustrations wherever required.

If anything is **NOT** clear, make relevant assumptions and solve the problem. In that case state your assumptions clearly. If you feel that a particular question is wrong then solve the "nearest" correct question by stating your version of question clearly. The instructor may not be available for clarification during the examination.

The students are allowed to carry one A4 sheet written in their own handwriting containing formulas. However, no block diagrams and derivations are allowed. The sheet shall carry the student's name and SC code and should be submitted along with the answer script.

1. With a neat block diagram explain briefly the the concept of stabilised platform system. (2)
2. What is time? What are the different types of times, define each one briefly. (3)
3. Show that rotation matrices are orthogonal matrices with determinant 1. (3)
4. Show that the quaternion operator $L_p(\vec{q}) = p^* \vec{q} p$ with $||p|| = 1$ represents rotation by clearly showing the axis of rotation and angle of rotation. (5)
5. Derive the kinematics of the DCM from first principles. (2)
6. An observatory in Mount Abu needs to point its telescope to observe the satellite Astrostat. The east longitude and north latitude of the observatory is 72°46′45.12″ and 24°39′17.28″, respectively. At 9:35:15 AM Indian Standard Time (IST) on Oct., 05, 2015 the position of the Astrostat was predicted by a computer to have the topocentric right ascension of 45° and the topocentric declination of 60° in the topocentric equatorial co-ordinate system. (15)

   Note: In topocentric equatorial co-ordinate system, the axes are parallel to the ECI frame but centered at the observer. The topocentric right ascension is measured from the topocentric axis which is parallel to ECI X-axis and topocentric elevation is measured from the topocentric plane which is parallel to equatorial plane of ECI frame.

   Compute the azimuth (angle measured from local north) and angular elevation (angle measured from local horizontal plane) of the telescope for observing Edusat so that the image of the Edusat falls along the visual axis of the telescope by first determining the rotation matrices using Euler angle axis method and hence the final transformation matrix. Hence compute the azimuth and elevation in observer frame.

End of exam.

INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY

Date: 26 Sept., 2024 Time: 2 Hours Total Marks: 60 No. of Students: 38

Mid-Semester Dept. of Avionics

Sub. No. AV491, Sub. Name: **Advanced Sensors and Interface Electronics**

Answer all questions

Question 1

Fill the blanks. (10 Marks)

(a) An oversampling factor of 256 is needed to improve the effective number of bits of an ADC by _____.

(b) An GMR material offers _____ resistance during zero magnetic field and it offers _____ resistance during saturating value of magnetic field.

(c) Benefits of employing a magnetic shield in GMR magnetometers include: _____ and _____.

(d) Axis of sensitivity of a GMR IC and Hall IC are along _____ and _____, respectively.

(e) Two examples of excess noise include: _____ and _____.

Question 2

(a) Find the transfer function of the circuit in Fig. 1. Assume that switches are controlled by a common signal (say, V_C), whose frequency is much higher than the frequencies of V_1, V_2 and V_3. The switches will be at position A when V_C is high and at position B, else. (6 Marks)

(b) Write the general expression of power-spectral density of an IC, and discuss its constituents. (2 Marks)

(c) Determine the noise-bandwidth of the circuit given in Fig. 2. (7 Marks)

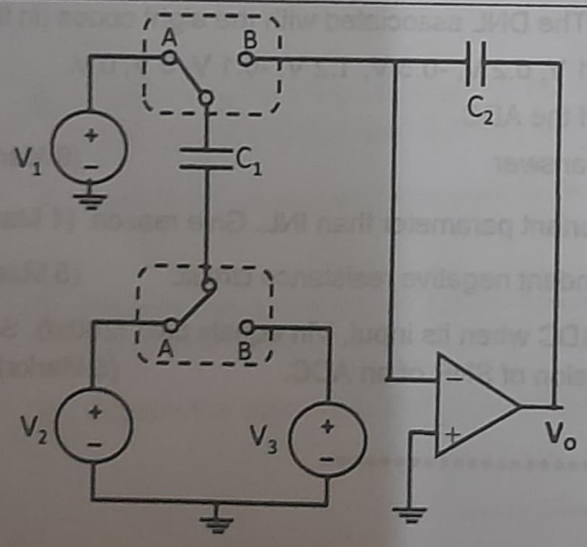


Fig. 1

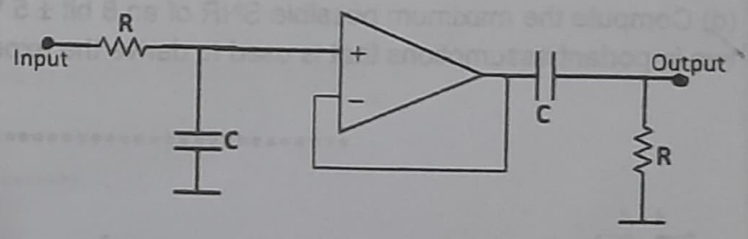


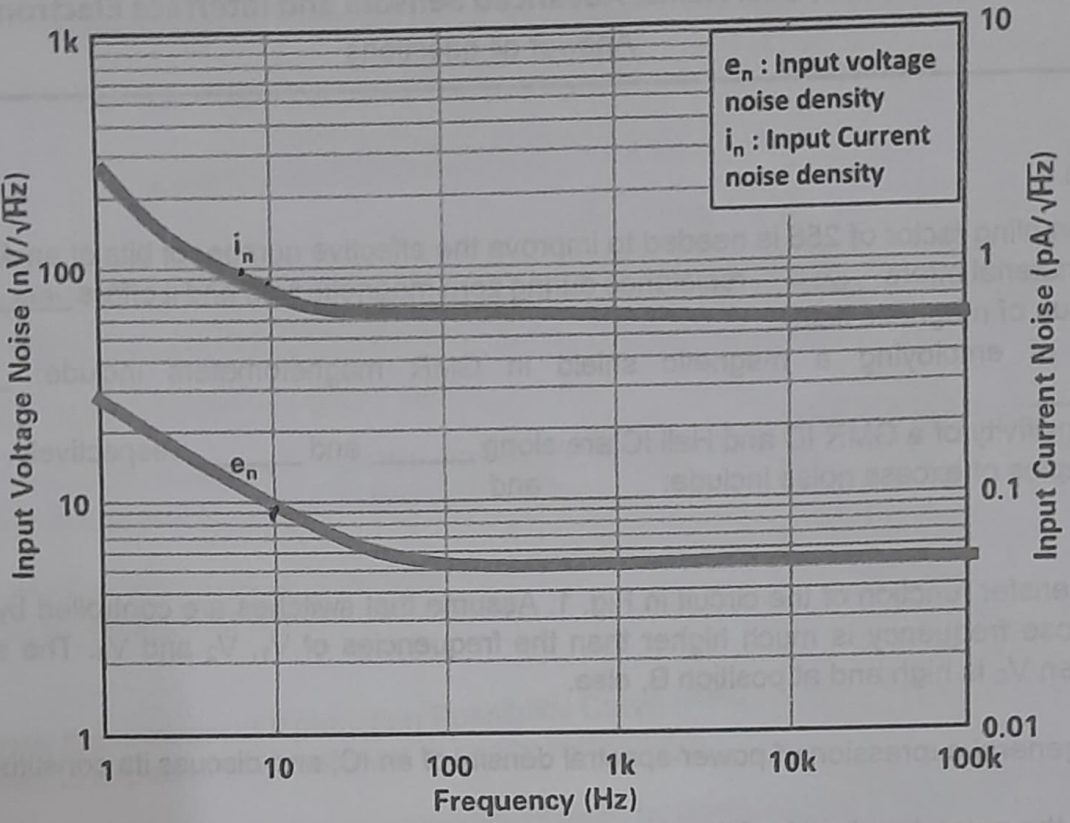
Fig. 2

Question 3 (5 + 5 + 5 = 15 Marks)

(a) Three 10 kΩ resistors are connected in parallel. Determine the noise-voltage spectral density of this parallel network at a temperature of 27°C. Take Boltzmann constant $k = 1.4 \times 10^{-23}$ J/K.

(b) Consider a differential amplifier (gain = 1) realized using four equal resistors. Draw its noise-equivalent model. Mention the expansions of all symbols in the noise model.

(c) Estimate the RMS input voltage noise present in the input of an opamp over a frequency span of 100 Hz to 10 kHz. Refer the graphs in the below figure, for the noise characteristics of the opamp. Make necessary approximations.



Question 3

(a) Consider a 3-bit ADC having a reference voltage of 8 V. The DNL associated with the eight codes (in their increasing order) of this 3-bit ADC are specified as 0.2 V, 0.1 V, 0.2 V, -0.5 V, 1.2 V, -0.1 V, 0 V, 0 V.

(i) What will be the DNL (in V) specification and INL (in V) of the ADC.

(ii) Will this ADC have missing codes? Give reason for your answer (6 Marks)

(b) Explain an ADC-application in which DNL is a more important parameter than INL. Give reason. (4 Marks)

(c) Discuss the circuit and an application of frequency-dependant negative resistance circuit. (5 Marks)

(d) Compute the maximum possible SNR of an 8 bit ± 5 V ADC when its input, Vin equals 5sin (200πt). State two important assumptions that is used to derive the expression of SNR of an ADC. (5 Marks)

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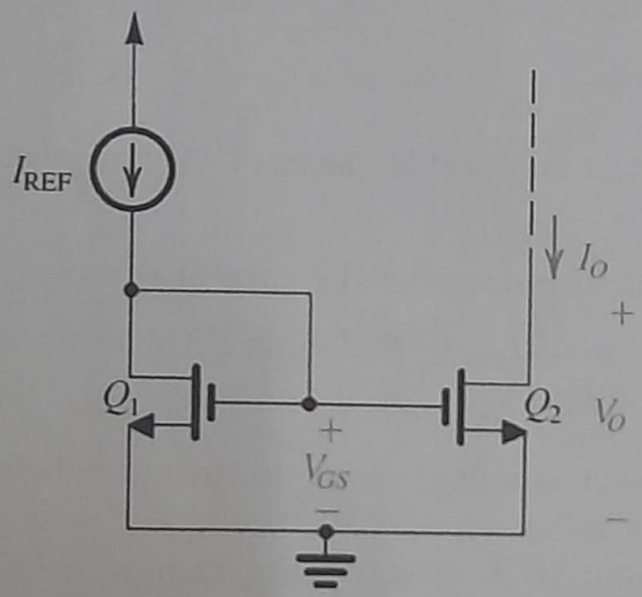
Indian Institute of Space Science and Technology
Department of Avionics
AVM 613 Analog VLSI Circuits
Mid Semester Examination - 2024

Time: 2 hours **Max. marks:** 30

Answer all the questions

1. Consider a simple NMOS current mirror shown below. Transistor Q_1 has a W/L = 250nm/40nm and Q_2 is made of 8 multipliers of Q_1 (8 identical transistors in parallel). $I_{REF} = 20\ \mu$A. Let $\mu_n C_{ox} = 0.25$ mA/V^2 and $V_{TH} = 0.35$ V. $\lambda = 0.7$. (5 marks)



(a) What is the output current? Calculate the output impedance of the current source (Q_2).

(b) If V_{TH} varies between 325 mV and 370 mV due to process and temperature variation, what is the variation in V_{GS}, assuming $\mu_n C_{ox}$ remains the same?

(c) What is gradient error? And how can you design the layout of this current mirror to minimize its impact?

(d) If V_o becomes 100 mV higher than V_{GS}, what is the change in the output current?

(e) For Q_1, what is the standard deviation of V_{TH}, if pelgrom's coefficient $A_{V_{TH}} = 5 \times 10^{-10}$?

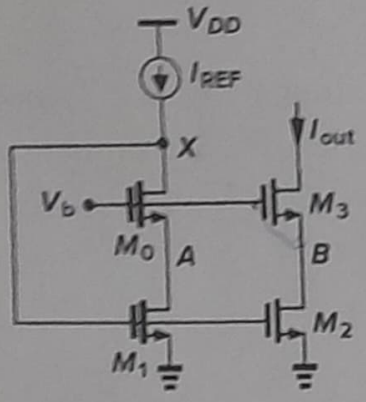
For the rest of the questions, assume the following:
$V_{DD} = 1.8$V

$\mu_n C_{ox} = 0.5\text{mA}/V^2$, $V_{THN} = 0.35\text{V}$

$\mu_p C_{ox} = 0.4\text{mA}/V^2$, $V_{THP} = \text{-}0.35\text{V}$

$\lambda_N = 0.1$, $\lambda_P = 0.1$.

2. In the circuit given below, $(W/L)_{1,2} = 20/0.5$, $(W/L)_{3,0} = 60/0.5$, and $I_{REF} = 100\mu\text{A}$. (5 marks)

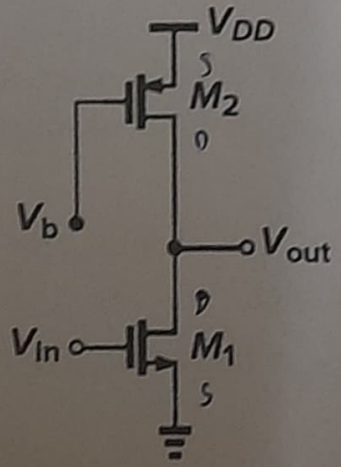


(a) Determine V_X and the acceptable range of V_b. (neglect channel length modulation)

(b) Calculate the output impedance of the current source.

(c) Estimate the deviation of I_{out} from $300\mu\text{A}$ if the drain voltage of M3 is higher than V_X by 1V.

3. Consider the common source amplifier shown in the figure below. Tom, the designer is given the following specifications: $C_L = 2$ pF (total capacitance at the output); UGF = 500 MHz; Expected DC level of the input = 0.7 V. Help Tom design the circuit, by calculating the following: (7 marks)



(a) What is the g_m and W/L that he should design M_1 for? (neglect channel length modulation effect.)

(b) What is the I_D that would result? (neglect channel length modulation effect.)

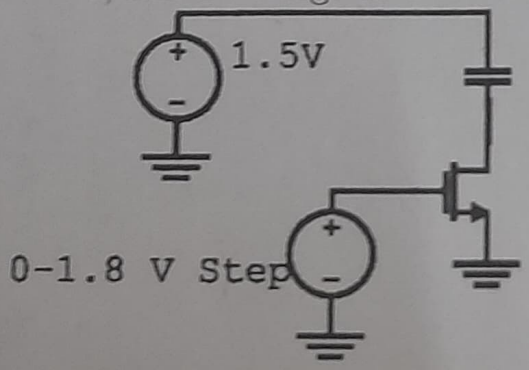
(c) For this I_D, calculate V_b at the gate of M_2 if Tom uses $\left(\frac{W}{L}\right)_2 = 2 \times \left(\frac{W}{L}\right)_1$? (neglect channel length modulation effect.)

(d) Calculate the output impedance and the small signal gain.

(e) What is the input-referred noise of this amplifier that you have helped Tom design? Provide only the expression.

4. To the circuit given above, add a resistor of 100 Ω at the source of M_1. Assume that the drain current is retained to be the same, by appropriately increasing the DC level of the input. What is the effective transconductance of the circuit? (3 marks)

5. In the figure shown below, the capacitor has a value of 1pF and for $t < 0$, has a voltage of 0V. At $t = 0$, the step happens. (3 marks)

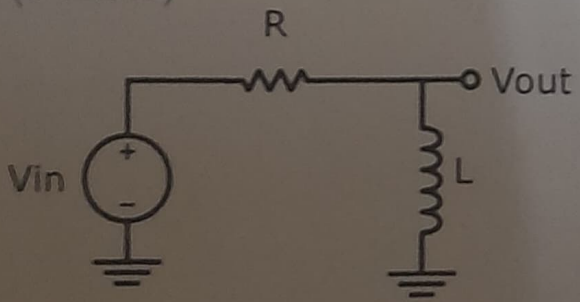


(a) What is the R_{on} of the transistor, if W/L = 2 μm/180 nm?

(b) What is the time constant of this circuit?

(c) At what time will the capacitor charge up to 95% of the final value?

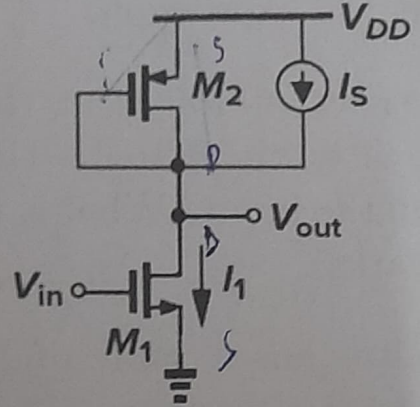
6. Consider a RL network as shown below. Let R = 1 KΩ and L= 1 μH. (3 marks)



(a) If the input is a 50% dutycycle square wave of time period 2 ns, sketch the output.

(b) If the input is a 50% duty cycle square wave of time period 100 ns, sketch the output.

7. For the figure shown below, derive the gain, input-referred noise voltage, output impedance, output signal swing limits. The current source $I_S = 0.75I_1$. Assume $\lambda = 0$. If a load capacitance (C_L) is connected to the output, what is the bandwidth? (4 marks)



Indian Institute of Space Science and Technology
Department of Humanities and Social Sciences

Mid Semester Examination
(Institute Elective)
HS466 Space Economics and Policy

Date of Examination : 04.10.2024
Time of Examination : 09.30 to 11.30 am Maximum Marks : 30

Answer any Six of the following (5 Marks each)

1. What is Space Economy? Explain the three components of Space Economy. Illustrate the development of Space Economy.

2. What are the properties of Aggregate Production Function? Explain how we can use this for estimating space economy.

3. Illustrate the concept of Production Possibility Curve (PPC). Explain how PPC can be used to explain the investment in space technology.

4. Describe the evolution of space capability of India by using Michael Porter's theory.

5. Explain how we can categorize the different types of goods. Illustrate how to estimate the optimal quantity of public good?

6. Explain the analytical framework for the estimation of Indian Space economy.

7. Explain the evolution of Indian space program by using the framework of Dr. Kasturi Rangan

8. Explain the objectives and unique features of Indian space program.

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