INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY
THIRUVANANTHAPURAM, 695 547
B.Tech End Semester Exam – December 2024

AV 412 – Satellite and Optical Communication

Time: 3 hour Date: 2/12/2024 Max. Marks: 50

Note: Write Satellite Communication in Seal A Answer sheet and Optical Communication in Seal B

PART - A - Satellite Communication

Answer the following

1. A receiver front end (RF front end) has a noise figure of 10 dB, a gain of 80 dB, and a bandwidth of 6 MHz. The input signal power is 10^{-11}W. Assume that the line is lossless and the antenna temperature is 150 K.
   (i) Find system noise temperature and (C/N) [3]
   (ii) If a preamplifier is used before the receiver front end with a noise figure of 3 dB, a gain of 13 dB. Find the improvement in (C/N) [2]
   (iii) If a coaxial feeder is connected between the preamplifier and receiver front end and has a loss of 2 dB, calculate the system noise temperature [2]
   (iv) If a feeder cable is connected between the antenna and the preamplifier, calculate the system noise temperature and Comment on the result. [2]
2. The following parameters apply to a satellite downlink: EIRP 22.5 dBW, free-space loss 195dB, other losses 1.5 dB, earth station (G/T) 37.5 dB/K. Calculate the (C/N_o) at the earth station. Assuming an output Back off power of 6dB is applied, what is the new value of (C/N_o)? [2]
3. Explain how rain attenuation affects the computation of the C/N ratio in the uplink and downlink scenarios. [3]
4. Explain the procedure of finding the generator polynomial of an (n,k) binary cyclic code. [2]
5. Describe the procedure for generating a systematic code for an (n,k) binary cyclic code, and provide a detailed explanation of the encoding circuit along with its illustration for (7,4) code. [2]
6. A convolutional code is described by $g_1 = [110]$ $g_2 = [101]$ $g_3 = [111]$. Find the transfer function and free distance for this code. [4]
7. Prove with a mathematical equation how the maximum likelihood decoder is equivalent to the minimum distance decoder for linear block code. [3]

PART - B - Optical Communication

Answer the following

1. Using energy band diagrams, explain the operation of an Erbium Doped Fiber Amplifier (EDFA). What is the importance of the metastable state in the energy band diagram? What are the sources of noise in this amplifier? Can a two-level system work as a laser? Explain. [4 marks]

2. A fibre optic communication link has the following parameters. (i) Source power = 0 dBm (ii) Detector sensitivity = -45 dBm (iii) Connector loss = 1 dB/connector (iv) Splice loss = 0.06 dB/Splice. If the total link length of 100 km is spanned by connecting two hundred 500 m cables of attenuation coefficient 0.3 dB/km and a system margin of 5 dB is required, determine whether or not an amplification of the optical signals is required in the link. If yes, determine the required minimum amount of amplification in dB. Assume that the fiber cables are connected to the source, detector, and amplifier using connectors and that individual fibre cables are connected through splicing. [4 marks]

3. With figure, discuss the design of a pn photodiode receiver. How do you decide the thickness of p and n layers? Define Quantum efficiency and Responsivity of a Photodiode. Plot the responsivity as a function of photon wavelength for a photodiode? Define cut-off wavelength for a Photodiode. What are the draw backs of conventional p-n photodiode? How does p-i-n photodiodes help in overcoming them? [4 marks]

4. The Figure 1 shows a Mach-Zehnder interferometer modulator made of LiNbO3. The rectangular shaped waveguides are made of Ti diffused LiNbO3 having an index of 2.355 while the refractive index of LiNbO3 is 2.30. The diffused waveguide is 3 m wide and has a depth of 500 nm. A Silica step index optical fiber which has a clad index of 1.55 and a core index which is 1 % higher than that of the clad index has to be coupled at the In and Out ports. Explain the various coupling losses and any other losses that can occur in this scheme. Discuss the coupling mechanisms by which those losses can be minimized. How do you ensure that the fiber is mechanically well connected with the LiNbO3 substrate? [5 marks]

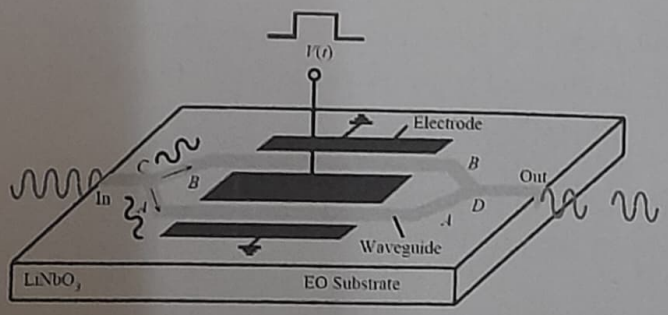


Figure 1: Mach-Zehnder interferometer modulator

5. For a Mach-Zehnder interferometer as shown in Figure 1, we have studied that when the phase of the waves in two arms differ by 180o, destructive interference occurs,

we get no light at the output port [Termed as 0]. If no light appears at the output port, explain what happens to that light. In other words, where does that light go? [2 marks]

6. Considering a cosine electric field inside the core and exponentially decaying fields in both the claddings of a symmetric dielectric planar waveguide, obtain an expression for the optical confinement factor for this waveguide. [6 marks]

INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY
THIRUVANANTHAPURAM, 695 547
B. Tech Seventh Semester ECE – End Semester – November 2024
AV411 – Navigation Systems and Sensors
Time: Three hours Date: 29/11/2024 Max. Marks: 50

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 students are allowed to carry two A4 sheets 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.

Inertial Sensors and Inertial Navigation Systems

1. Define Navigation, Guidance and Control and explain the NGC loop using a neat block diagram. (2)

2. Inertial Navigation
   (a) With a neat block diagram explain the signal flow of stabilised platform inertial navigation system. (2)
   (b) With a neat block diagram explain the signal flow of strapdown inertial navigation system. (2)

Particle dynamics in moving coordinate system

3. Let e^1, e^2 and e^3 be unit vectors of a right handed moving system where ω is the angular velocity of the moving system.
   (a) Show that derivative e^1 is orthogonal to itself. (1)
   (b) Show that $\frac{d}{dt}e^1 \cdot e^2 = -\frac{d}{dt}e^2 \cdot e^1$, where $\cdot$ stands for dot-product. (1)

4. With a neat diagram, derive the acceleration expression in terms of tangential and normal component for a particle in curvilinear motion, clearly indicating the radius of curvature. (2)

5. With a neat diagram derive the five term kinematics of a particle motion in a moving frame. (2)

6. A projectile with a mass of 1 Ton is launched vertically from the surface of the Earth with a velocity of 100m/s. Assuming negligble wind, would the projectile rise up vertically from where it was launched. Justify. Compute the position of the projectile on the sky when it reaches zero velocity in relation the observer at the launch site. Assume that the latitude and longitude of the of the launch site to be 60° and 30°, respectively. (3)

Coordinate-systems and Coordinate Transformation

7. Consider the following representation of the Euler Angles and Euler sequences

$$R_x(\theta_x)R_y(\theta_y)R_z(\theta_z) = \begin{bmatrix} c_y c_z & c_y s_z & -s_y \\ s_x s_y c_z - c_x s_z & s_x s_y s_z + c_x c_z & s_x c_y \\ c_x s_y c_z + s_x s_z & c_x s_y s_z - s_x c_z & c_x c_y \end{bmatrix}$$

Let the Euler angles be $\theta_x = 10$, $\theta_y = 90$, $\theta_z = 30$.

(a) Compute the quaternion representing the above rotation. (2)

(b) Does there exist another distinct set of Euler angles in the range [0,360] and same sequence such that it represents the same orientation. If so determine another distinct set of Euler angles ϕ_x, ϕ_y, ϕ_z that represents the same orientation otherwise justify. (2)

(c) Give the quaternion representing the above distinct set of Euler angles. (1)

(d) What do you conclude from this? (1)

8. Derive an expression for derivative of a quaternion in terms of body angular rate and derivative of the quaternion rotation operator. (2)

9. Properties of DCM matrix

(a) What are properties of DCM matrix? (1)

(b) Which, if any, of the following coordinate systems is not rotating? (1)

A. North-East-Down (NED) B. East-North-Up (ENU)
C. ECEF (Earth-centered Earth-fixed) D. Earth Centered Inertial (ECI) E. None of the above

10. Consider the following matrix

$$A = \begin{bmatrix} 0 & 0 & -1 \\ \sin(\psi) & \cos(\psi) & 0 \\ \cos(\psi) & -\sin(\psi) & 0 \end{bmatrix}$$

(a) Determine weather the above matrix is a rotation matrix and justify. If the above matrix is not a rotation matrix modify it to a rotation matrix. (1)

(b) Determine the axis and angle of rotation for the above/converted matrix. (2)

11. A given co-ordinate transformation is uniquely represented by a unit quaternion [T/F]. Justify. (1)

12. Find the quaternion corresponding to the DCM matrix $\begin{bmatrix} -\frac{5}{8} & \frac{\sqrt{3}}{4} & \frac{3^{3/2}}{8} \\ \frac{\sqrt{3}}{4} & -\frac{1}{2} & \frac{3}{4} \\ \frac{3^{3/2}}{8} & \frac{3}{4} & \frac{1}{8} \end{bmatrix}$ (1)

13. Show that for any $t \in \mathbb{R}$ the matrix Q_t defined below is a rotation matrix. Find its axis of rotation and cosine of the angle of rotation. (3)

$$Q_t = \frac{1}{1+t+t^2} \begin{bmatrix} -t & t+t^2 & 1+t \\ 1+t & -t & t+t^2 \\ t+t^2 & 1+t & -t \end{bmatrix}$$

14. The IRNSS 1A satellite was launched into geosynchronous orbit with an inclination of 27.47 degrees with equator, Perigee 35,704Km and Apogee 35,866 Km. On 31st Dec., 2020 at 12:35 IST IRNSS makes an observation of Sun and the Star Sirius. The co-ordinates as measured by IRNSS of the Sun are $(2,1,3)$ and $(1,-1,1)$ in the body and ECI frame respectively and that of the Sirius are $(1,0,1)$ and $(-1,1,0)$ in the body and ECI frame respectively.

(a) Is it possible to determine the orientation of IRNSS body frame with respect to the ECI frame with the above given measurements? Justify (1)

(b) If the answer to the above question is yes then justify by determining the transformation matrix between the IRNSS body frame and ECI frame. If the answer to the previous question is no then how many additional vector measurements are required to obtain the transformation matrix between IRNSS body frame and ECI frame? Give an example of additional measurement vectors and the corresponding transformation matrix. (2)

15. An inertial measuring unit consisting of three rate gyroscopes and three servo accelerometers are placed in a rocket at the launchpad located in Sydney, 33.8600° S, 151.2094° E Australia. The input axes of the inertial measuring unit are aligned with North, East and Zenith axis. Determine the measurements obtained by all the gyroscopes and accelerometers. (1)

16. 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. (8)

    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.

17. With neat diagrams explain the working principles of the following sensors: (5)
    (a) MEMS accelerometer
    (b) Momentum wheel gyros
    (c) Coriolis Gyros
    (d) Laser Gyros
    (e) Accelerometer

INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY

Date: 6 Dec., 2024 Time: 3 Hours Total Marks: 100 No. of Students: 38

End-Sem Dept. of Avionics

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

Answer all questions

PART – A (20 Marks)

Instructions for Question 1 to 5: Mention the correct choice and main equation/concept that justifies your choice.

Question 1: Consider a bio signal which represents a human heart rate activity. Typical heart rate can be assumed as 72 beats-per-minute. The signal is affected by power line interference of 50 Hz frequency. Which one filter among the following options can be best used for proper filtering the bio signal.

(a) 1st order Low-pass-filter with 5 Hz cutoff frequency
(b) 2nd order High-pass-filter with 5 Hz cutoff frequency
(c) 2nd order Low-pass-filter with cutoff frequency of 0.05 Hz
(d) 3rd order High-pass-filter with cutoff frequency of 0.05 Hz

Question 2: A dual-slope ADC has an integration period set to 100 ms. Which of the following input signal frequencies will be rejected by the ADC?

(a) 5 Hz only (b) 5 Hz and 10 Hz (c) 50 Hz only (d) 50 Hz and 60 Hz

Question 3: For a 12-bit unipolar ADC with a 10 V full-scale range, the quantization error is

(a) 2.44 mV (b) 4.88 mV (c) 255 mV (d) 512 mV

Question 4: Let HPF, LPF, and BPF represent transfer functions of second-order low-pass, high-pass, and band-pass filters. Then, the second-order all-pass transfer function can be written as

(a) HPF + LPF (b) HPF-LPF (c) HPF+BPF-LPF (d) HPF-BPF+LPF

Question 5: Bio-impedance signal can be properly acquired using

(a) Single-electrode configuration (b) Dual-electrode configuration
(b) Three-electrode configuration (d) Four-electrode configuration

Question 6 (10 Marks)

The following table shows a list of sensing problems and some measurement electronics schemes. Choose the most feasible measurement scheme (from second column) for each sensing problem (given in first column). Briefly justify your answer, in a few sentences.

Sensing Problem	Measurement Electronics Techniques
1. Conductivity measurement of metals B	A. Doppler effect ultrasonic flowmeters X
2. Magnetic measurements for geophysical surveys G	B. Low frequency eddy current testing X
3. Flow-rate measurement of clean fluids . E	C. Twin hall-sensor-based ring module
4. Welding defects in sub-surface regions D	D. High-frequency eddy current testing
5. Continuous heart-rate monitoring for portable applications H	E. Transit time ultrasonic flowmeter X
	F. Wet-electrode ECG X
	G. Flux-gate sensors
	H. Dry-electrode ECG X

Part B (80 Marks)

Question 7

(6 + 4 + 3 + 7 = 20 Marks)

(a) A piezoelectric transducer has a capacitance of 1000 pF and sensitivity of 400 pC/μm. The connecting cable has a capacitance of 300 pF, while the oscilloscope used for read-out has an input impedance of 1 MΩ paralleled with 50 pF.

(i) Compute the high-frequency sensitivity (mV/μm) of the entire measurement system.

(ii) What is the lowest frequency that can be measured with 5 % amplitude error by the entire system?

(b) Derive the output-expression of a simple linearizing circuit that can be used for the typical GMR-based magnetometer (present in bridge-circuit form).

(c) Draw the schematic of a through-shaft angle sensor unit and label its important parts.

(d) Consider the circuit of a linearization-scheme for magnetic angle sensors shown in Fig. 1. Here, OC_1 is a comparator, SW is a switch and *LPF* stands for a low-pass filter. V_R and $-V_R$ represent DC reference voltages. The voltage v_{sn} is the magnetic-sensor signal. v_{sn} is proportional to cosine of the angle.

(i) What should be the properties of the voltage V_A and the design criterions for the *LPF* so that the circuit can act as a linearizer with 180° range.

(ii) Derive the expression for output, v_O of this circuit provided above conditions are satisfied.

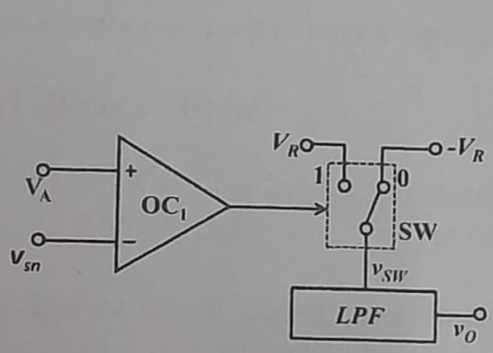


Fig. 1

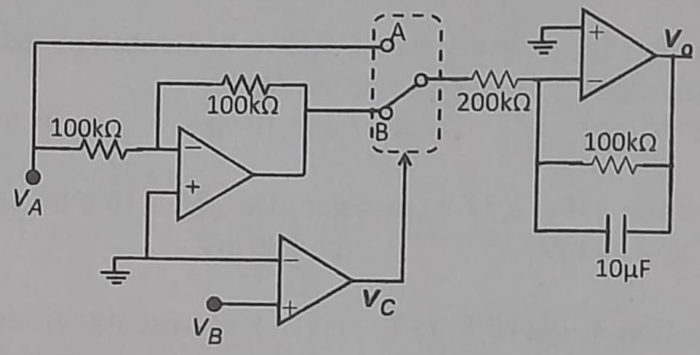


Fig. 2

Question 8

(4 + 6 + 6 + 4 = 20 Marks)

(a) With the help of BVD model, show that the parallel resonant frequency of a piezo-electric transmitter is very close to its series resonant frequency.

(b) A piezoelectric crystal has an effective mass of 10 g, stiffness of 10^{10} N m^{-1} and damping constant of 200 Ns m^{-1}. Electrical capacitance of crystal is 1000 pF and its charge to force sensitivity is 2×10^{-10} C N^{-1}. Design a closed-loop oscillator which can be used to operate the crystal at its series resonant frequency.

(c) In the circuit (Fig. 2), the switch will be at position-A if the signal, v_c = HIGH and at position B, if v_c = LOW. Determine the output, Vo for the following conditions. Make valid approximations to simplify the calculations.

(i) $v_A = \sin(100\pi t)$ and $v_B = \cos(100\pi t)$

(iii) $v_A = \sin(100\pi t)$ and $v_B = \sin(200\pi t)$

(d) Draw the internal structure of a capacitive probe that can be used for non-contact measurement of power line voltage in a cable. Comment on the effect of the thickness of the cable wire on the probe performance.

Question 9

(4 + 4 + 12 = 20 Marks)

(a) Design a two-input summing amplifier using switched capacitor technique.

(b) Design a GIC circuit which can simulate an inductance of 0.5 mH. Use a capacitance of 10 nF and equal-valued resistors in the circuit.

(c) Consider a 10-pin instrumentation amplifier (IA) IC shown in Fig. 3a. The internal structure of this IC and its pinout arrangement is shown in Fig. 3b. For example, pin 5 and 6 represent the positive and negative power supply terminals, while pin 1 represent the IC output. Assume R = 22 kΩ.

(i) Show how the above-mentioned IA IC can be used to provide a gain of 45 for a Lead-3 ECG system. Use an external resistor if needed. Draw an illustrative diagram to demonstrate the interfacing of the ECG electrodes to this IC. In your diagram, show the terminals/electrodes to which the pins 3, 4, 7, 8, 10 need to be connected.

(ii) Further, it is noted that IA IC has input impedance of 10 MΩ and CMRR = ∞. Assume that the mismatch in electrode impedances cannot exceed 20 kΩ. A 50 Hz power-line interference of amplitude 10 mV is expected to be present as a common-mode term at the input of the IA. Compute the magnitude of the 50 Hz component in the IC output (i. e., the pin-1).

(iii) Mention 1 advantage of using a right-leg driver circuit.

(iv) Illustrate how the pins 2 and 9 of the IC can be used to aid in the design of the right-leg driver circuit.

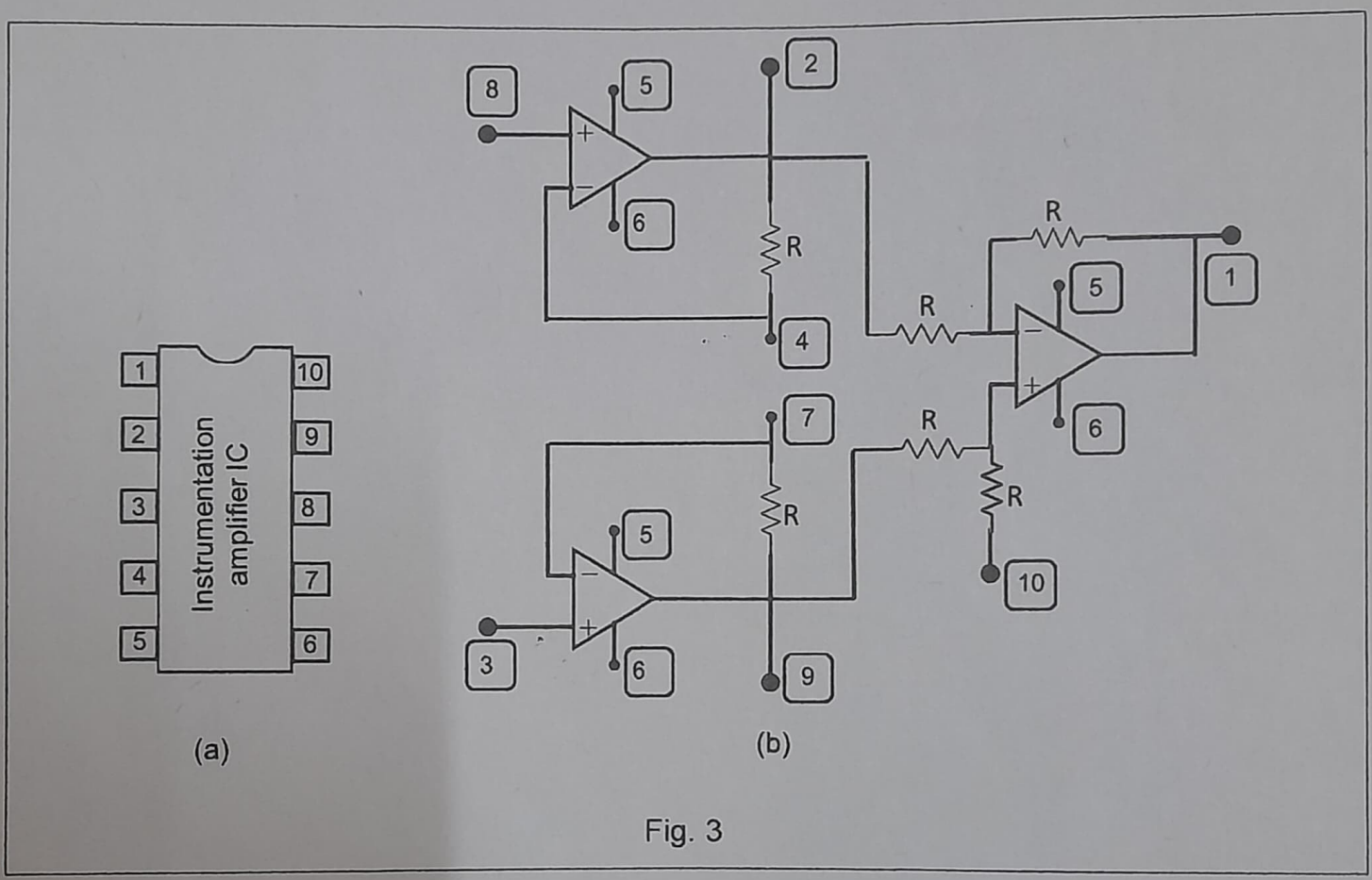


Fig. 3

Question 10 (5 + 5 + 5 + 3 + 2 = 20 Marks)

(a) Design an efficient capacitive measurement scheme for level measurement of a conductive liquid present in a plastic (cylindrical) tank.

(b) Explain a magnetic sensor arrangement that can efficiently measure the current flowing through a conductor. Assume that limited portion of the conductor can only be accessed.

(c) Prove that the sigma-delta ADC architecture provides noise shaping feature.

(d) Find the SNR of a forward-biased diode over a bandwidth of 1 MHz if the diode-current is 100 μA.

(e) Justify the statement "Cable resistance compensation can be achieved for a two-wire connected remote resistive sensor".

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

Time: 3 hours **Max. marks:** 40

Answer all the questions For all the questions, assume the following:

$V_{DD} = 1.8\text{V}$

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

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

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

You can assume square law model for MOSFET operation. Some formulae for use in your calculations are provided below:

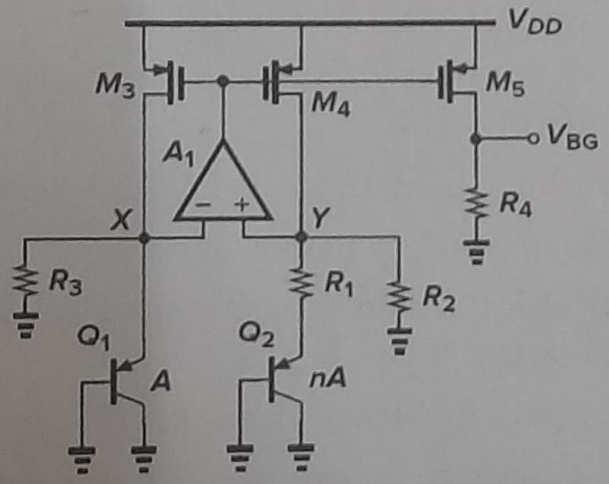
$I_D = \frac{\mu C_{ox}}{2}\frac{W}{L}(V_{GS} - V_{TH})^2$

$g_m = \mu C_{ox}(W/L)(V_{GS} - V_{TH}) = \sqrt{2I_D \mu C_{ox}(W/L)} = \frac{2I_D}{(V_{GS} - V_{TH})}$

$r_0 = \frac{1}{\lambda I_D}$

Answer all the following questions:

1. Consider the circuit shown below. Let $V_T = 25\text{mV}$. n=8. $|V_{BE1}| = 0.82\text{V}$. R1=2KΩ, R2 = R3 = 4KΩ, R4 = 2KΩ. For the first four questions, you can provide the answers considering the circuit at room temperature (T=300K). (5 marks)



(a) In steady state, what is the voltage across R1? (1 mark)

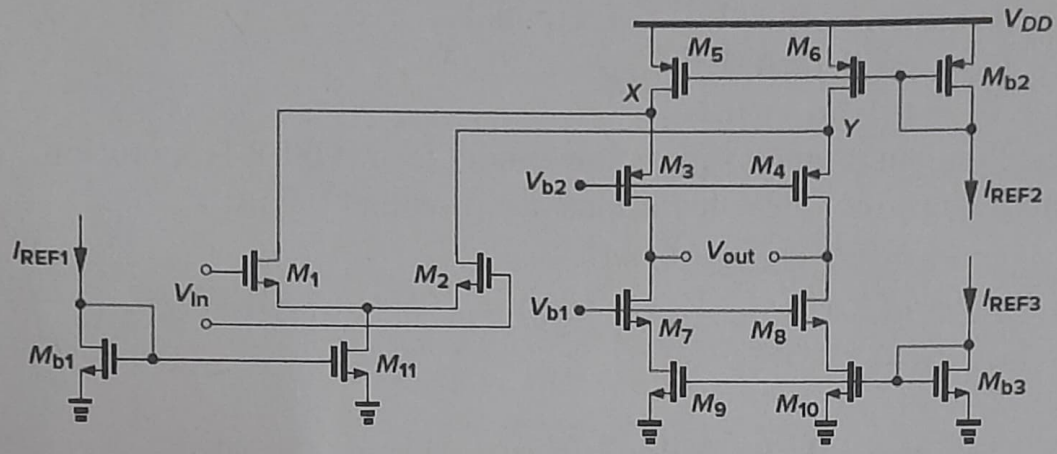
(b) What is the current through resistors R2, R3? (1 mark)

(c) What is the current through M4? (1 mark)

(d) What is the bandgap boltage V_{BG}? (1 mark)

(e) What is the nature of the current through R1 and R2 (PTAT/ CTAT/ independent of temperature)? (1 mark)

2. Consider a folded cascode OTA shown in the figure. Let Iref1=Iref2=Iref3 $= 20\mu A$. You can assume square-law equations for calculations and neglect channel length modulation for the first few questions till it is required explicitly. The transconductance of M3, M4, M7, M8, M9, M10 = 0.8 mS and the transconductance of M5, M6 = 1.5 mS.(13 marks)



(a) If the minimum voltage required across M11 is 200mV, and $V_{CM,min}$ = 0.6V, what is the current through M1,2 required for a transconductance of 2mS? (2 marks)

(b) What is the W/L ratio of M1,2 ? (ıark)

(c) The current through M9,10 is 40μA. What is the ratio of $(W/L)_{5,6}$ to $(W/L)_{Mb2}$? (1 mark)

(d) What is the output impedance of the OTA? (2 marks)

(e) What is the open loop gain? (1 mark)

(f) What is the bandwidth if a load capacitance of 2pF is connected at the output? (1 mark)

(g) Calculate the unity gain frequency (1 mark)

(h) Identify the non-dominant poles (expression is sufficient). (2 marks)

(i) Write the expression for the input referred noise, including flicker noise ($\overline{V_{n,in}^2}$). (2 marks)

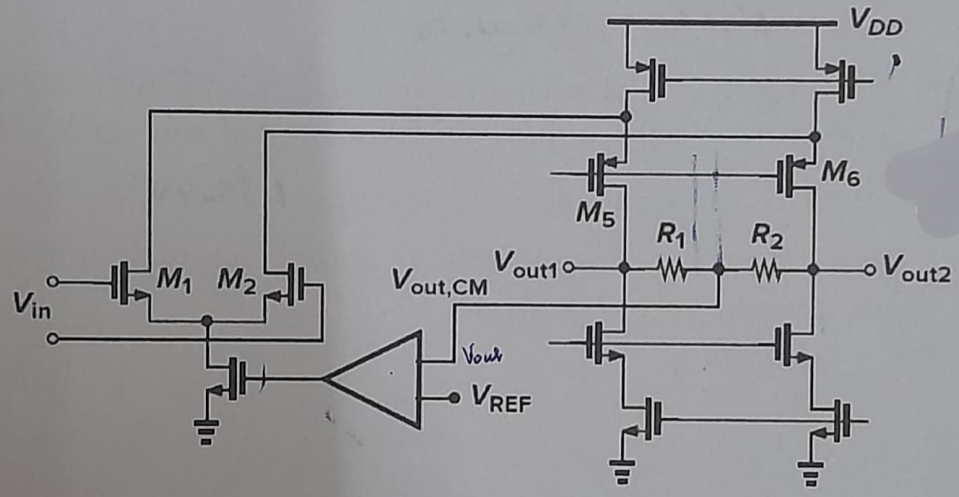
3. A two-stage opamp is being stabilized through miller compensation. Let ω_{p1} and ω_{p2} be the output poles of the 1^{st} and 2^{nd} stages respectively. Also, let $\omega_{p1} < \omega_{p2}$ In the s-plane, show how the poles move when miller compensation is used. (2 marks)

4. An engineer is working on improving the stability of an opamp. When a frequency-independent feedback network with a β of 0.4 is used with the opamp in negative feedback, the phase margin is observed to be 50°. How do you think the phase margin would change if the feedback factor β is reduced? Why? (2 marks)

5. An opamp is used in negative feedback. The bode plot of the loop gain ($A\beta$) shows that the phase margin is 25°. For the closed loop circuit, what will be the magnitude of peaking at the unity gain frequency in the frequency response? (3 marks)

6. An fully differential opamp with rail to rail output is required to be designed. The designer has employed a simple 5-stage OTA as the first stage. Can you help him complete the design with a second stage that can provide a rail-to-rail output swing? For a differential sinusoidal input, draw the waveforms at different nodes of the second stage. (3 marks)

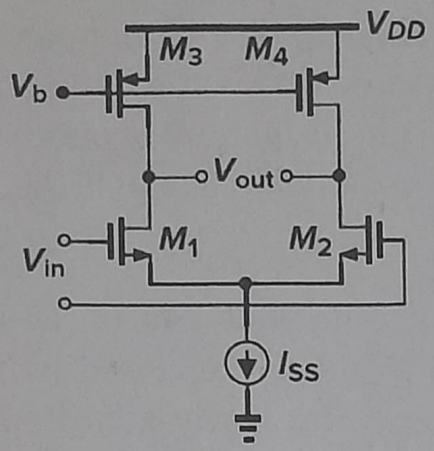
7. Consider the circuit below. (3 marks)



(a) Identify the correct polarity of the opamp used for CMFB. (1 mark)

(b) Write the expression of the gain of the folded cascode opamp, and comment on what is the impact of the common mode sensing resistors. (2 marks)

8. Consider the OTA shown below. $I_{SS} = 0.5$ mA. $(\frac{W}{L})_{1,2} = 20/0.35$. $(\frac{W}{L})_{3,4} = 50/0.35$. The current source has an output impedance of 20 KΩ. (9 marks)



(a) What is the transconductance of this OTA? (1 mark)

(b) Calculate the output impedance. (1 mark)

(c) Calculate the differential mode voltage gain (1 mark)

(d) Calculate the common mode gain (1 mark)

(e) Calculate CMRR (1 mark)

(f) What is the minimum input common mode voltage required? (1 mark)

(g) The OTA is loaded with a capacitance of 1pF on both differential arms. What is the unity gain frequency of the OTA? (1 mark)

(h) Calculate the value of V_b. (1 mark)

(i) Derive the input referred voltage noise PSD (including flicker noise - expression only). (1 mark)

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

End Semester Examination December 2024
(Institute Elective Course for B Tech final year students)

HS466 Space Economics and Policy

Date of Examination : 13.12.2024
Time of Examination : 9.30 am to 12.30 pm Maximum Marks : 50

I. Answer **all** the following questions (1 mark each, Total 10 Marks)

1. UNGA resolution 1472 (XIV), 12 Dec 1959 identified which of the following mandates for COPUOS?
    a. Promote international cooperation for the peaceful use of outer space.
    b. Study programs for space research, and legal issues arising from space exploration.
    c. Facilitate exchange of information and cooperation between States.
    d. All of the above

2. Identify the sub-committee of COPOUS
    a. Legislative and Technological Subcommittee
    b. Legislative Subcommittee
    c. Scientific and Technical Subcommittee
    d. None of the above

3. What is the method used for calculation of Return of Investment (RoI) for an equipment with original cost 'A' and life span 'B'.

4. Article related to the National Appropriation is mentioned in which treaty of the International Space Law?
    a. Liability Convention
    b. Rescue Agreement
    c. Outer Space Treaty
    d. None of the above

5. The following article of the outer space treaty gives thrust to the Liability and responsibility of the launching state.
    a. Art II & III
    b. Art I & V
    c. Art VI & VII
    d. None of the above

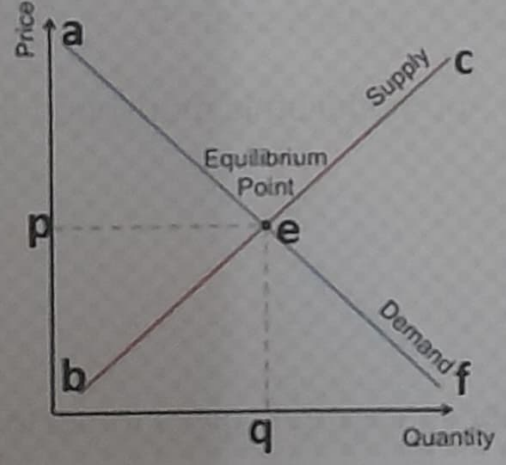
6. The incident in which Liability was invoked
    a. Kosmos 954 crash in Cambodia
    b. Kosmos 954 crash in Canada
    c. Skylab debris fall in Australia
    d. None of the above

7. As per the Space Policy 2023, the _____ is mandated for overseeing the distribution of responsibilities outlined in the policy.
    a. INSPACE
    b. NSIL
    c. DOS
    d. ISRO

8. Space Policy 2023 identifies _____ for commercializing space technologies and platforms created through public expenditure.
    a. INSPACE
    b. ANTRIX
    c. NSIL
    d. ISRO

9. The _____establish legal frameworks for the use of lunar resources, emphasizing that the Moon cannot become the property of any State or entity.
    a. Artemis Accords
    b. Moon Agreement
    c. Liability Convention
    d. None of the above

10. Which is the area of consumer surplus in the following figure:



II. Answer **any 10** of the following questions (2 marks each, Total 20 Marks)

11. Economic Impact Assessment
12. What is Multiplier? Explain its direct impacts.
13. Factors affecting supply and demand aspects of space sector in India
14. State the different approaches to Costing

15. Explain the concept of space spin-offs and discuss their relevance to India's socio-economic development. Illustrate with examples
16. Explain the 'Downstream Space activities'
17. In three points, summarize the evolution of costing philosophy in ISRO
18. Describe the factors influencing for pricing of space launches
19. What is New Space?
20. What is SROI? Explain the features and its processes
21. Explain how space technology will lead to efficiency improvements in sectors other than the space sector.

III. Answer **any four** of the following Questions (5 Marks each, Total 20 Marks)

22. Compare and contrast the principles of unbalanced growth theory with the dynamics of developing a space economy. How can these principles guide strategic investment in the space sector?
23. Analyze the role of the space economy in India's vision for self-reliance (Atmanirbhar Bharat).
24. Discuss how the Cobb-Douglas production function can be applied to model the contributions of labor, capital, and technology in the space economy.
25. Define space technology spin-offs. Discuss their significance in translating space research into applications that benefit various sectors of the economy. Also discuss the role of public-private partnerships (PPPs) in leveraging ISRO's technological innovations for industrial and economic growth.
26. Differentiate between MEC and MEI. How are these concepts interrelated, and what role do they play in determining the feasibility of investments in the space sector?
27. How can private sector participation accelerate India's progress toward becoming a leader in the global space economy? Compare India's approach to private sector participation in the space sector with that of other leading space-faring nations, such as the USA and Europe.

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INDIAN INSTITUTE OF SPACE SCIENCE & TECHNOLOGY

EndSem Exam/ B.Tech 7th Semester / INSTITUTE ELECTIVE

Course Title: ID 412 / INTRODUCTION TO INDIAN KNOWLEDGE SYSTEMS

Time: 9:30 AM - 12:30 PM

Date: DECEMBER 12, 2024

Total Marks: 40

Answer all questions in full

1. What is the katapayadi method? Cite at least two examples or instances where katapayadi has been used.

(5 marks)

2. Briefly describe at least three important contributions from the Kerala School of Mathematics and Astronomy.

(5 marks)

3. Why are some sounds musical and others just noise? Your answer should be a summary of Charles Taylor's Christmas lectures at the Royal Institute.

(5 marks)

4. What are all the essential features that have to be present in any musical instrument for the production of musical sound?

(5 marks)

5. Explain the significance of each element of the Indic value system. Based on the classroom discussion, critically analyze the limitations of a society structured around only three elements—*Dharma*, *Artha*, and *Kama*.

(4 marks)

6. Contrast Elon Musk's perspective, as expressed in his social media post—"What is life without purpose? But there is a purpose! It is to expand to the stars and thereby understand the Universe"—with Yuval Noah Harari's view: "If we don't find a way to translate power into happiness, how to be satisfied with what we have—instead of running after more and more—there is a very big danger that we will destroy ourselves."

   Analyze these contrasting viewpoints in the context of the Indic value system, focusing on how their philosophies align or diverge from the principles of Indian Value System. Discuss the compatibility of their views with the Indic emphasis on harmony between material pursuits and spiritual contentment.

(6 marks)

7. Examine the essence of "Truth," "Goodness," and "Beauty" as individual values and explore their convergence within the framework of the Indic concept of ultimate value.

(5 marks)

8. Analyze and interpret the implications within the following statements by Rabindranath Tagore:

   a. *"The tragedy of human life consists in our vain attempts to stretch the limits of things which can never become unlimited, to reach the infinite by absurdly adding to the rungs of the ladder of the finite."*

   b. *"The ideal that India tried to realise led her best men to the isolation of a contemplative life, and the treasures that she gained for mankind by penetrating into the mysteries of reality cost her dear in the sphere of worldly success."*

(5 marks)