

Khulna University, Khulna
Electronics and Communication Engineering Discipline
Fourth Year First Term Examination, Session: 2024-2025
Course No.: 0714 09 ECE 4109

Full Title of the Course: **Radar and Satellite Communication**
 Credit Hours: **3.00** Full Marks: **60** Time: **03 Hours**

- The figure in the margin indicates full marks. The questions are of equal value.
- Use separate sheet for each section.

SECTION A

There are **FOUR** questions in this section. Answer any **THREE** questions.

- | | | |
|------|--|----|
| 1(a) | Define RADAR and maximum unambiguous range. Explain the relation between the unambiguous range and PRF with a suitable diagram. [L-1; CLO-1] | 03 |
| 1(b) | Draw the block diagram of a conventional superheterodyne pulse radar and explain the function of each block. [L-2; CLO-1] | 04 |
| 1(c) | The moon as a radar target may be described as follows: average distance to the moon is 3.84×10^8 m; experimentally measured radar cross section is 6.64×10^{11} m ² ; and its radius is 1.74×10^6 m. [L-5; CLO-1] | 03 |
| | (i) Evaluate the round-trip time (seconds) of a radar pulse to the moon and back. | |
| | (ii) Determine the pulse repetition frequency (PRF) required to avoid range ambiguities. | |
| 2(a) | Define noise figure and radar pulse integration. Show that noise figure can never be less than 1 or 0 dB. [L-1,3; CLO-2] | 03 |
| 2(b) | What do you mean by the false-alarm and missed-detection? For a high security defense RADAR system, how will you choose a proper threshold value as a RADAR engineer? [L-4; CLO-2] | 04 |
| 2(c) | The average time between false alarms is specified as 30 min and the receiver bandwidth is 0.4 MHz. [L-5; CLO-2] | 03 |
| | a. What is the probability of false alarm? | |
| | b. What is the threshold-to-noise power ratio (V_T^2/ψ_0)? | |
| 3(a) | What are clutter echoes in radar systems, and how do they affect target detection? [L-3; CLO-2] | 02 |
| 3(b) | Derive the expression used to determine the velocity of a moving target using the Doppler effect, with proper mathematical justification. [L-5; CLO-2] | 04 |
| 3(c) | What is the highest frequency that a radar can be operated if it is required to have a maximum unambiguous range of 3.704×10^5 m and no blind speeds less than 308.6 m/s. [L-5; CLO-2] | 04 |
| 4(a) | Explain the working principle of radar angle tracking techniques, supported by suitable diagrams. [L-2; CLO-1] | 04 |
| 4(b) | Identify the factors affecting tracking accuracy in radar systems, and explain any one factor in detail. [L-3; CLO-1] | 03 |
| 4(c) | A phase comparison monopulse radar has antenna spacing of 0.5λ . If the measured phase difference is 30° , estimate the angle of arrival of the target. [L-6; CLO-1] | 03 |

SECTION B

There are **FOUR** questions in this section. Answer any **THREE** questions.

- | | |
|--|----|
| 5(a) State Kepler's second law of motion. Using this law, show that ratio of speeds at apogee and perigee is equal to $(1 - e)/(1 + e)$. [L-1,3; CLO-1] | 04 |
| 5(b) The orbit for an earth-orbiting satellite has an eccentricity of 0.15 and a semimajor axis of 3000 km. Determine its periodic time, apogee and perigee heights. Assume a mean value of 6371 km for the earth's radius. [L-2; CLO-1] | 03 |
| 5(c) Describe briefly the main effects of the earth's equatorial bulge. [L-6; CLO-1] | 03 |
| 6(a) Explain what is meant by the geostationary orbit. Also, explain why there is only one geostationary orbit. [L-2,3; CLO-1] | 03 |
| 6(b) An earth station at latitude $30^\circ S$ is in communication with an earth station on the same longitude at $30^\circ N$, through a geostationary satellite. The satellite longitude is 20° east of the earth stations. Calculate the antenna-look angles for each earth station. Also, calculate the round-trip time, assuming propagation delay only. [L-3; CLO-1] | 07 |
| 7(a) Describe the TT&C facilities of a satellite communications system. [L-2; CLO-1] | 03 |
| 7(b) Explain the three axes (with neat sketch) to define a satellite's attitude. [L-2; CLO-1] | 03 |
| 7(c) Explain the TDMA concept using reference station for burst synchronization in satellite broadcast. [L-2; CLO-1] | 04 |
| 8(a) Prove that, $[FSC] = 32.4 + 20 \log r + 20 \log f$. [Symbols hold their usual meanings]. [L-3; CLO-1,3] | 03 |
| 8(b) In a link-budget calculation at 12 GHz, the free-space loss is 206 dB, the antenna pointing loss is 1dB, and the atmospheric absorption is 2dB. The receiver $\{G/T\}$ is 19.5 dB/k, and receiver feeder losses are 1 dB. The EIRP is 48dBW. Calculate the carrier-to-noise spectral density ratio. [L-3; CLO-1,3] | 03 |
| 8(c) Describe the operation of a typical VSAT system. [L-2; CLO-1,4] | 04 |

Khulna University, Khulna**Fourth Year First Term Examination, Session: 2024-2025****Electronics and Communication Engineering Discipline****Course No.: ECE 4125****Full Title of the Course: Measurements and Electronic Instrumentations****Full Marks: 60****Time: 03 Hours****Credit: 03**

- The figure in the margin indicates full marks. The questions are of equal value.
- Use separate sheet for each section.

SECTION AThere are **FOUR** questions in this section. Answer any **THREE** questions.

- 1(a) Write the name of the methods to measure low resistance. Describe Kelvin Bridge method to measure low resistance with necessary circuit diagram and equations. What are the main features of this method? 05
- 1(b) Suppose, you are using Murray loop test to localize a short-circuit fault. Here, the faulty cable has a length of 8 km. The sound cable has the same length and cross-section like the faulty cable. The resistances of the ratio arms are $95\ \Omega$ and $55\ \Omega$ at balance. Calculate the distance of the fault from the test end. 05
- 2(a) Define shunt. Derive its expressions with figure to increase the range of an ammeter. 03
- 2(b) A moving coil instrument with an internal resistance of $R_m = 100\ \Omega$ and a full scale current of $I_m = 1.2\ \text{mA}$, is to be converted into a multi-range d.c. voltmeter with ranges $0 - 12\ \text{V}$, $0 - 50\ \text{V}$ and $0 - 100\ \text{V}$. Find the values of various resistances using the potential divider arrangement. 04
- 2(c) What do you mean by power factor? What are the effects of power factor on industrial metering and tariff? 03
- 3(a) Derive the equations to measure an unknown inductance using the Maxwell Inductance-Capacitance bridge. Also derive the equation of Q factor. Draw the circuit diagram. 05
- 3(b) The four arms of an AC bridge has the following parameters: 05
- Arm **ab**: an imperfect capacitor C_1 with an equivalent series resistance of r_1 .
 Arm **bc**: a non-inductive resistance R_3 , Arm **cd**: a non-inductive resistance R_4 , and Arm **da**: an imperfect capacitor C_2 with an equivalent series resistance of r_2 with a resistance R_2 .
 Suppose a supply of $455\ \text{Hz}$ is given between 'a' and 'c' terminal and the detector is connected between 'b' and 'd' terminal. At balance: $R_2 = 4.8\ \Omega$, $R_3 = 2000\ \Omega$, $R_4 = 2850\ \Omega$, and $C_2 = 0.5\ \mu\text{F}$ and $r_2 = 0.5\ \Omega$. Draw the circuit diagram and calculate the value of C_1 , r_1 and the dissipation factor of the capacitor.

- 4(a) Draw the internal structure of CRT of an oscilloscope. Describe the main parts of it briefly. 04
- 4(b) Define Lissajous pattern. Suppose, two signals $X = 5\sin 4\pi t$ and $Y = 5\sin 10\pi t$ are applied simultaneously to the vertical amplifier and the horizontal amplifier respectively. Draw the Lissajous pattern that will be formed on the CRT screen. 03
- 4(c) Describe the main function of a time base generator with necessary circuit diagram and wave shape. 03

SECTION B

There are **FOUR** questions in this section. Answer any **THREE** questions.

- 5(a) What is inverse transducer? Explain the operation of an inductive transducer with necessary figure. 04
- 5(b) Derive the expression of output voltage of a POT. Also, find out its sensitivity. 03
- 5(c) Briefly explain the input and transfer characteristics of a transducer. 03
- 6(a) What is the basic principle of flow-rate measurement? Explain how capacitive voltage divider method can be used for the measurement of liquid level. 04
- 6(b) Write down the advantages and disadvantages of moving magnet type transducer for the measurement of linear velocity. 03
- 6(c) Justify how a three-amplifier configuration of an instrumentation amplifier is used for common mode signal rejection. 03
- 7(a) What is quantization error? Justify in a D/A converter, the analog output voltage is proportional to the digital input. 03
- 7(b) Justify how decade counter can be obtained by modifying the scale-of-16 counter. 03
- 7(c) An analog voltage signal whose highest significant frequency is 1 kHz, is to be digitally coded with a resolution of 0.01% covering a range of 0-10 V. Calculate the minimum number of bits in the digital code, analog value of LSB, rms value of quantization error, minimum sampling rate, aperture time required by A/D converter and dynamic range of converter in dB. 04
- 8(a) Define telemetry. Explain current and position telemetering system with necessary figure. 04
- 8(b) Explain the operation of dual slope integrator DVM with necessary figure. 03
- 8(c) What are the main components of a digital data acquisition system? Mention some functions of this system. 03

Khulna University, Khulna
Fourth Year First Term Examination, Session: 2024-2025
Electronics and Communication Engineering Discipline
Course No.: 071409 ECE 4103
Full Title of the Course: VLSI Technology
Full Marks: 60 Time: 03 Hours Credit: 03

- The figure in the margin indicates full marks. The questions are of equal value.
- Use separate sheet for each section.

SECTION A

There are **FOUR** questions in this section. Answer any **THREE** questions.

- | | |
|---|----|
| 1(a) For a MOS device, prove that transconductance is directly related by its geometry or difference between gate to source and threshold voltages (in saturation). [CLO 1, 2, 3 ; L3] | 05 |
| 1(b) Determine the induced charge, drain to source current, gate/channel capacitance, and gate capacitance per unit area where oxide layer permittivity is 4, oxide layer thickness is 2 μm , gate to source voltage 5 V, threshold voltage is 1 V, drain to source voltage is 5 V, channel length is 2 μm , and channel width is 2.5 μm , respectively. Assume that, this transistor is operated in non-saturation mode. [CLO 1, 2, 3 ; L3] | 05 |
| 2(a) Draw and explain step-by-step CMOS n-well fabrication process. [CLO1; L2] | 05 |
| 2(b) Draw the flowchart of VLSI design cycle. [CLO 1, 2; L1] | 02 |
| 2(c) Show that $I_{ds} = C_0 \mu \frac{W}{2L} (V_{gs} - V_t)^2$ for a MOS transistor in saturation. Symbols have their usual meanings. [CLO2; L4] | 03 |
| 3(a) Draw the stick diagram and mask layout of the following expressions:
$Y = \overline{A + B + C}$ use nMOS, and (ii) $Y = \overline{X \cdot Z}$ use CMOS [CLO 1, 2; L4] | 05 |
| 3(b) Estimate the rise time and fall time for a CMOS inverter. [CLO 1, 2; L5] | 05 |
| 4(a) Determine the delays of cascaded CMOS inverters driving a large off-chip capacitor consider that ∇V_{in} and numbers of inverters are odd. [CLO 1; L1,2] | 04 |
| 4(b) Describe with necessary figures the five distinct regions of operation of a CMOS inverter. [CLO 1; L1,2] | 03 |
| 4(c) A particular layer of MOS circuit has a resistivity $\rho = 1 \text{ ohm cm}$. A section of this layer is 55 μm long and 5 μm wide and has a thickness of 1 μm . Calculate the resistance from one end of this section to the other. What is the value of R_s ? [CLO 1, 2, 3 ; L3] | 03 |

SECTION B

There are **FOUR** questions in this section. Answer any **THREE** questions.

- | | | |
|------|--|----|
| 5(a) | Draw the stick diagram of the following expressions using CMOS technology. Follow Euler's path.
$Z = \overline{A + B.C + D}$ [CLO3; L3] | 04 |
| 5(b) | Draw the stick diagram of a 4:1 MUX using CMOS technology and configure it to work as an XOR gate. [CLO3; L3] | 06 |
| 6(a) | Design a 4-line Gray code to binary code converter. Also draw its stick diagram. [CLO 1, 2, 3 ; L4] | 03 |
| 6(b) | Determine pair delay of a pseudo-nMOS inverters. [CLO 1, 2, 3 ; L2] | 03 |
| 6(c) | Draw the stick diagram of a 2 by 2 barrel shifter. [CLO3; L3] | 04 |
| 7(a) | Design a 3 bit serial-parallel multiplier. [CLO3; L3] | 06 |
| 7(b) | Discuss some considerations to be taken into account in VLSI design. [CLO1; L2] | 04 |
| 8(a) | Draw the circuit diagram of a four transistor dynamic memory cell and explain the read and write operation. [CLO3; L4] | 05 |
| 8(b) | Draw a one-transistor dynamic memory cell and construct its stick diagram. How will you determine that which logic was stored in it? If $C_{bit} = 50 C_m$, calculate the change of voltage. [CLO 1, 2, 3 ; L3] | 05 |

Khulna University, Khulna
Fourth Year First Term Examination, Session: 2024-2025
Electronics and Communication Engineering Discipline
Course No.: ECE 4103 (R)
Full Title of the Course: VLSI Circuits & Design
Full Marks: 60 Time: 03 Hours Credit: 03

- The figure in the margin indicates full marks. The questions are of equal value.
- Use separate sheet for each section.

SECTION A

There are **FOUR** questions in this section. Answer any **THREE** questions.

- | | |
|---|----|
| 1(a) Sketch and explain the CMOS p -well fabrication steps. | 05 |
| 1(b) Explain the operation of channel formation of a p MOS enhancement mode transistor with proper schematic. | 05 |
| 2(a) In the inverter circuit, what is meant by $Z_{p,u}$ and $Z_{p,d}$? Derive the required ratio between $Z_{p,u}$ and $Z_{p,d}$ if an NMOS inverter is to be driven from another NMOS inverter with one pass transistor. | 06 |
| 2(b) Derive the equation of drain to source current of a MOS transistor for the nano-saturated region. | 04 |
| 3(a) For a CMOS inverter, calculate the shift in the transfer characteristics when the β_n/β_p ratio is varied from 1/1 to 10/1. | 05 |
| 3(b) A particular layer of MOS circuit has a resistivity $\rho = 1$ ohm cm. A section of this layer is 55 μm long and 5 μm wide and has a thickness of 1 μm . Calculate the resistance from one end of this section to the other. What is the value of R_s ? | 05 |
| 4(a) Draw the mask layout of the following expression using CMOS technology. $Z = \overline{(A + B).C}$ | 04 |
| 4(b) What is the basic purpose of stick diagram? Draw the stick diagram for two input NOR gate. Also give the procedural steps. | 04 |
| 4(c) What are the problems of long polysilicon wire? | 02 |

SECTION B

There are **FOUR** questions in this section. Answer any **THREE** questions.

- | | |
|---|----|
| 5(a) Draw the stick diagram and mask layout of the following expression using CMOS technology.
$Z = \overline{A + B'C}$ | 05 |
| 5(b) Draw the stick diagram of a 2:1 MUX using nMOS technology and configure it to work as an OR gate. | 05 |
| 6(a) The thickness and width of a metal power line are 1 μm and 7.5 μm , respectively. Calculate the number of nMOS inverters that can be powered by the line. Given that $Z_{p.u.} = 8/1$ and $Z_{p.d.} = 1/1$ and $J_{th} = 1 \text{ mA}/\mu\text{m}^2$. | 03 |
| 6(b) Design a 2-phase non-overlapping clock generator using nMOS logic and also draw the stick diagram of its each unit. | 04 |
| 6(c) In a dynamic shift register, data is stored in the gate capacitor. Determine the holding time if $V_{DD} = 1.8 \text{ V}$, leakage current = 0.01 nA and gate capacitance = 0.001 pF. | 03 |
| 7(a) Draw the stick diagram of a MUX based full adder using nMOS technology. | 06 |
| 7(b) Draw the stick diagram of the leaf cell of an inverting shift register. | 04 |
| 8(a) Sketch the floor plan for AND/OR and NOR based PLA. | 05 |
| 8(b) Design a CMOS (NAND-based) PLA for a full adder. To design (i) Construct K map (ii) Form Boolean expression and (iii) Draw the circuit | 05 |

Khulna University
Fourth Year First Term Examination, Session: 2024-2025
Electronics and Communication Engineering Discipline
Course No.: ECE 4101
Full Title of the Course: Industrial and Power Electronics
Full Marks: 60 **Time: 03 Hours**

- The figure in the margin indicates full marks. The questions are of equal value.
- Use separate sheet for each section.

SECTION A

There are **FOUR** questions in this section. Answer any **THREE** questions.

- 1.(a) Draw the V - I characteristics of an SCR. Describe the operating principle of an SCR with gate triggering. 4
- 1.(b) Discuss four different ways of turning on an SCR. 2
- 1.(c) Define string efficiency and derating factor. What is the purpose of series and parallel connections of SCR? 4
- 2.(a) Describe the construction of a UJT, including a necessary diagram, and draw its V - I characteristic curve. 4
- 2.(b) In a data sheet, the intrinsic stand-off ratio (η) of a UJT is given from 0.74 to 0.86. Evaluate the maximum and minimum peak-point voltage for the UJT with $V_{BB} = 25$ V. 3
- 2.(c) Explain the working principle of the DIAC and TRIAC-based AC phase control circuit. 3
- 3.(a) What do you mean by reverse recovery time? Classify power diodes based on their recovery characteristics and manufacturing techniques. 3
- 3.(b) For a punch-through power diode, deduce the following relation: 4

$$V_{BD} = E_{BD} W_d - \frac{q N_d W_d^2}{2\epsilon},$$
 where symbols have their usual meanings.
- 3.(c) Explain the working principle of a schottky power diode with a necessary diagram. 3
- 4.(a) Briefly describe an RC firing circuit of a Thyristor. 3
- 4.(b) In an SCR half-wave rectifier circuit, the measured average load current is 1A at a firing angle of 30° . Calculate peak-load current. 3
- 4.(c) Deduce the output current expression for a single-phase half-wave rectifier circuit utilizing an inductive load. 4

SECTION B

There are **FOUR** questions in this section. Answer any **THREE** questions.

- 5.(a) What is the main principle of dynamic braking? Describe dynamic braking of shunt-wound DC motor with proper circuit diagram. 5
- 5.(b) Why plugging is not usually recommended for motor braking? Explain the emergency plugging circuit of motor braking with complete circuit diagram. 5
- 6.(a) Sketch the block diagram of a simple single phase inverter and explain its operation. 5
- 6.(b) Design a timer circuit using a UJT and SCR. 5
- 7.(a) Explain the operation of a bifilar stepper motor with necessary diagram. How can transistors be utilized to drive the stepper motor windings? 4
- 7.(b) A 250 V DC shunt motor has armature resistance 0.25Ω , armature current 50 A, and speed 750 rpm, respectively. If the flux of this motor is reduced by 10% without changing the load torque, find the new speed of the motor. 2
- 7.(c) Draw the circuit diagram and waveforms of a Buck converter and show that $C_{min} = \frac{(1-D)V_o}{8V_r L f^2}$; where the symbols have their usual meanings. 4
- 8.(a) Discuss the operation of a basic vehicle control circuit. 5
- 8.(b) Describe the functions of bias and feedback winding in a magnetic amplifier. 5

Khulna University, Khulna
Electronics and Communication Engineering Discipline
Fourth Year First Term Examination, Session: 2024-2025
Course No.: ECE 4201 (R)

Full Title of the Course: **Semiconductor Processing and Fabrication Technology**

Credit Hours: **3.00**

Full Marks: **60**

Time: **03 Hours**

- The figure in the margin indicates full marks. The questions are of equal value.
- Use separate sheet for each section.

SECTION A

There are **FOUR** questions in this section. Answer any **THREE** questions.

- | | |
|---|----|
| 1(a) Define wafer, Chip, and die. Give one difference among them. | 03 |
| 1(b) Analyze the advantages of ICs over discrete circuits, specifically focusing on how batch fabrication contributes to reduced costs and higher reliability. | 04 |
| 1(c) What do you understand about die yield in IC fabrication? A wafer contains 250 dies. After testing, 200 are usable. Calculate the die yield and comment on whether the yield is acceptable for mass production. | 03 |
| | |
| 2(a) Why silicon is preferred over germanium for IC fabrication? Explain. | 03 |
| 2(b) Explain the two-step flattening and polishing process (Rough Polish and CMP). How does Chemical Mechanical Polishing (CMP) differ from conventional abrasive lapping? | 03 |
| 2(c) Explain the operation of Molecular Beam Epitaxy (MBE) and list its primary advantages and disadvantages compared to other deposition methods. | 04 |
| | |
| 3(a) Contrast the 'Dry' and 'Wet' thermal oxidation processes. Which process is preferred for growing gate oxides in MOSFETs, and why? | 03 |
| 3(b) Explain the role of silicon dioxide (SiO ₂) in IC fabrication. | 02 |
| 3(c) During a constant-source diffusion, the surface concentration is maintained at $N_s = 5 \times 10^{20} \text{ cm}^{-3}$. After 2 hours at 1000 °C, the diffusion depth is 0.5 μm. Estimate the impurity concentration at this depth using the erfc relation. Given that $D = 3 \times 10^{-14} \text{ cm}^2/\text{s}$ at 1000 °C, and $\text{erfc}(1.70) = 0.01621$. | 05 |
| | |
| 4(a) Explain the difference between diffusion and ion implantation as doping techniques. | 02 |
| 4(b) Calculate the 'Selectivity' of an etching process if the etch rate of polysilicon is 40 nm/min and the etch rate of thin oxide is 2 nm/min. | 02 |
| 4(c) List the four general types of wafer surface contamination and the corresponding methods used to remove them. | 02 |
| 4(d) Describe the two-step RCA cleaning process (SC-1 and SC-2). What specific residues does each step aim to remove? | 04 |

SECTION B

There are **FOUR** questions in this section. Answer any **THREE** questions.

- 5(a) List all the steps involved in photolithography and describe the liftoff process using necessary sketches. 06
- 5(b) Mention some differences between thermal evaporation and sputtering. 04
- 6(a) Draw the cross-sectional view of the following components connected in the shown way. 06

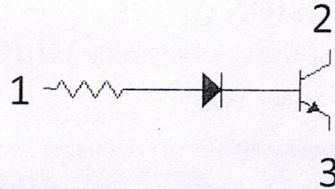


Fig. 6(a)

- 6(b) Draw the cross-sectional view of a CMOS inverter. 04
- 7(a) Show the fabrication of the MOS step by step by using suitable sketches. 06
- 7(b) Draw the cross-sectional view of a MOS capacitor. Also, draw the equivalent circuit of it and explain. 04
- 8(a) Describe the latch-up problem using the necessary figures. How SOI does solve this problem? 04
- 8(b) List the steps involved in IC packaging process. Describe any two of them. 06

Khulna University, Khulna
Electronics and Communication Engineering Discipline
Fourth Year First Term Examination, Session: 2024-2025
Course No.: 0714 09 ECE 4105
Full Title of the Course: Digital Signal Processing
Credit Hours: 3.00 Full Marks: 60 Time: 03 Hours

- The figure in the margin indicates full marks. The questions are of equal value.
- Use separate sheet for each section.

SECTION A

There are **FOUR** questions in this section. Answer any **THREE** questions.

- 1(a) Determine the linear convolution for the two sequences $x(n) = \{3, 2, 1, 2\}$ and $h(n) = \{1, 2, 1, 2\}$. 04
 [L-5; CLO-1,2]
- 1(b) A digital communication link carries binary-coded words representing samples of the input signal $x_a(t) = 3\cos 600\pi t + 2\cos 1800\pi t$. The link is operated at 10,000 bits/s, and each input sample is quantized into 1024 different voltage levels. 06
- (i) What are the sampling frequency and folding frequency?
 (ii) Determine the Nyquist rate.
 (iii) What are the frequencies in the resulting discrete-time signal $x(n)$?
 (iv) Determine the resolution. [L-3; CLO-1]
- 2(a) Find impulse response of the system described by the difference equation, 06
 $y(n) + y(n-1) - 2y(n-2) = x(n-1) + 2x(n-2)$. [L-3; CLO-2,3,4]
- 2(b) Consider a system with an impulse response [L-3; CLO-2] 04

$$h(n) = \begin{cases} \left(\frac{1}{2}\right)^n, & 0 \leq n \leq 4 \\ 0, & \text{elsewhere} \end{cases}$$
 Determine $x(2)$ and $x(4)$ in the input sequence for the output sequence
 $y(n) = \{1, 2, 2.5, 3, 3, 3, 2, 1, 0, \dots\}$
 $\uparrow$
- 3(a) Find the inverse z transform of $X(z) = \frac{2z^3 - 5z^2 + z + 3}{(z-1)(z-2)}$ with ROC $|z| < 1$ using partial fraction expansion method. [L-3; CLO-3] 05
- 3(b) Find the z transform $X(z)$ and sketch the pole-zero plot with ROC for the following sequence 05
 $x(n) = \left(\frac{1}{2}\right)^n u(n) + \left(\frac{1}{3}\right)^n u(n)$. [L-3; CLO-3]
4. Compute 8-point DFT of the sequence $x(n) = \{1, 2, 3, 4, 4, 3, 2, 1\}$ using radix-2 DIT-FFT algorithm. 10
 [L-4; CLO-2,3,4]

SECTION B

There are **FOUR** questions in this section. Answer any **THREE** questions.

- 5(a) List and briefly explain the basic computational elements required to implement a digital network for a linear shift-invariant system. [L-2; CLO-1] 03
- 5(b) Define linear phase filters and explain their significance. Furthermore, demonstrate how the symmetry property $h(n) = h(N - n)$ in a Type I FIR filter (where N is even) can be utilized to modify the direct form structure to reduce the total number of multiplications. [L-3; CLO-1] 03
- 5(c) A linear shift-invariant system has a unit sample response given by 04
- $$h(0) = -0.01 \quad h(1) = 0.02 \quad h(2) = -0.10 \quad h(3) = 0.40$$
- $$h(4) = -0.10 \quad h(5) = 0.02 \quad h(6) = -0.01$$
- (i) Draw a signal flowgraph for this system that requires the minimum number of multiplications.
- (ii) If the input to this system is bounded with $|x(n)| < 1$ for all n , what is the maximum value that the output, $y(n)$, can attain? [L-3; CLO-1]
- 6(a) Compare the Cascade Form and the Parallel Structure for IIR filter implementation. Specifically, differentiate them based on the mathematical representation of the system function $H(z)$. [L-4; CLO-2] 03
- 6(b) Contrast the computational requirements—specifically the number of multiplications, additions, and delays—between Direct Form I and Direct Form II structures for a causal IIR filter of order p and q . [L-4; CLO-2] 03
- 6(c) Use the Rectangular window design method to design a linear phase FIR filter of order $N = 24$ to approximate the following ideal frequency response magnitude: 04
- $$|H_d(e^{j\omega})| = \begin{cases} 1 & |\omega| \leq 0.2\pi \\ 0 & 0.2\pi < |\omega| \leq \pi \end{cases} \quad \text{[L-3; CLO-2]}$$
7. A band pass FIR filter of length 7 is required. It is to have lower and upper cut off frequencies of 3kHz and is intended to be used with a sampling frequency of 24kHz. Determine the filter coefficients using Hamming window. Consider the filter to be causal. [L-5; CLO-4,5] 10
- 8(a) In the process of designing IIR filters from analog prototypes, explain the primary purpose and utility of 'Analog Low-Pass Filter Prototypes' (such as Butterworth or Chebyshev). [L-2; CLO-4] 03
- 8(b) Given an analog filter transfer function $H_a(s)$, outline the systematic steps required to convert it into a digital filter $H(z)$ using the Bilinear Transformation. [L-3; CLO-4] 03
- 8(c) Use the bilinear transformation to design a first-order low-pass Butterworth filter that has a 3-dB cutoff frequency $\omega_c = 0.5\pi$. [L-3; CLO-4] 04

Khulna University, Khulna
Fourth Year First Term Examination, Session: 2024-2025
Electronics and Communication Engineering Discipline
Course No.: ECE 4123 (R)
Full Title of the Course: Control Systems
Full Marks: 60 Time: 03 Hours Credit: 03

- The figure in the margin indicates full marks. The questions are of equal value.
- Use separate sheet for each section.

SECTION A

There are **FOUR** questions in this section. Answer any **THREE** questions.

- 1(a) Draw and describe the block diagram of a generalized control system. Also discuss the applications of control systems in engineering fields and everyday life. 05
- 1(b) Determine the transfer function of a PID controller shown in Fig.Q1b. 05

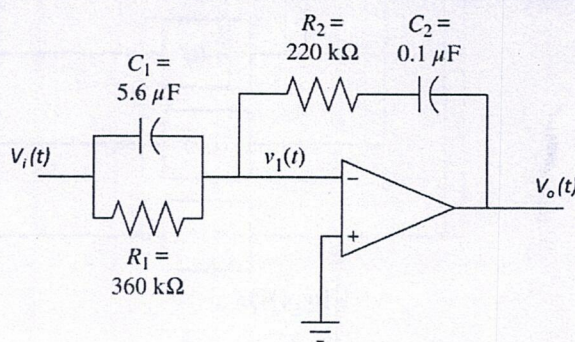


Fig.Q1b

- 2(a) Find the state equations for the translational mechanical system shown in Fig. Q2b. 05

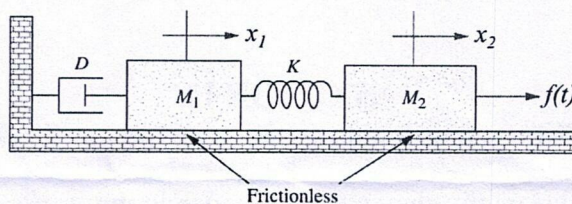


Fig.Q2b

- 2(b) Compute the transfer function of the system whose state-space model is given below: 05

$$\dot{\mathbf{x}} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -2 & -3 \end{bmatrix} \mathbf{x} + \begin{bmatrix} 10 \\ 0 \\ 0 \end{bmatrix} u$$

$$y = [1 \quad 0 \quad 0] \mathbf{x}$$

- 3(a) Consider a unity feedback control system with the closed loop transfer function 05

$$\frac{C(s)}{R(s)} = \frac{Ks + b}{s^2 + as + b}$$

Determine the open loop transfer function. Show that the steady error in the unit ramp input response is given by $e_{ss} = \frac{a-k}{b}$.

- 3(b) Given the transfer function $G(s) = \frac{100}{s^2 + 15s + 100}$, find T_p , %OS, T_s , and T_r , where the symbols hold their usual meaning. 05

- 4(a) Using the block diagram reduction technique reduce the system shown in Fig.Q4a to a single transfer function. 05

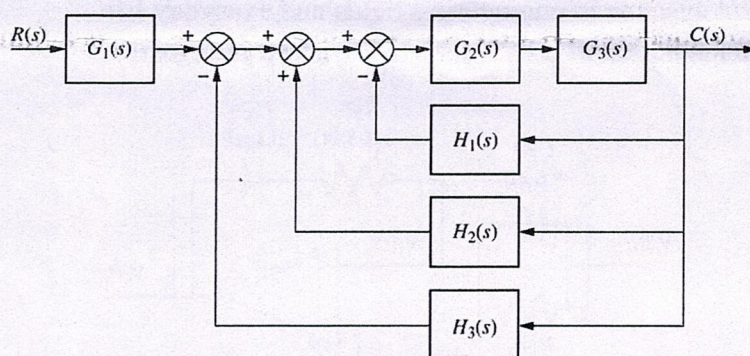


Fig. Q4a

- 4(b) A unity feedback system has the following forward transfer function: $G(s) = \frac{10(s+20)(s+30)}{s(s+25)(s+35)}$, 05
Find the steady-state error for the following inputs: $15u(t)$, $15tu(t)$, and $15t^2u(t)$.

SECTION B

There are **FOUR** questions in this section. Answer any **THREE** questions.

- 5(a) A unity feedback control system is characterized by open loop transfer function 04

$$G(s) = \frac{K(s + 13)}{s(s + 3)(s + 7)}$$

Using Routh criterion, calculate the range of values of K for the system to be stable.

- 5(b) Consider the equation $T(s) = \frac{128}{s^8 + 3s^7 + 10s^6 + 24s^5 + 48s^4 + 96s^3 + 128s^2 + 192s + 128}$ 06

Determine the number of poles in the right-half, left-half and imaginary axis. Is the system stable?

- 6(a) Explain the significance of root locus in control system analysis? Why does the root locus start at poles and end at zeros? 03
- 6(b) Plot the root locii for the closed loop control system with $G(s) = \frac{K(s+1)}{s^2(s+3.6)}$, $H(s) = 1$. 07
- 7(a) Sketch the polar plot for $G(s) = \frac{1}{s(s+1)}$. 04
- 7(b) Consider the transfer function $G(s)H(s) = \frac{60}{(s+1)(s+2)(s+5)}$. Using Nyquist stability criterion determine whether the closed loop system is stable or not. 06
- 8(a) Draw the Bode plot of the following function $G(s) = \frac{1}{1+sT}$. 03
- 8(b) For the given transfer function, $G(s)H(s) = \frac{2}{s(1+0.5s)(1+0.05s)}$, determine the gain margin and phase margin. 07

Khulna University
Electronics and Communication Engineering Discipline
4th Year, 1st Term Examination, Session: 2024-2025
Course No.: 0714 09 ECE 4117, Full Title of Course: Internet of Things
Full Marks: 60 Time: 03 Hours Credit: 3.0

- * The figures in the margin indicate full marks. The questions are of equal value.
- * Use separate sheet for each section.

Section A

There are **Four** questions in this section. Answer any **Three** questions.

- | | |
|--|----|
| 1(a) Define the Internet of Things (IoT) and explain its five key characteristics. [L1; CLO1] | 04 |
| 1(b) Compare and contrast the Request-Response communication model with the WebSocket-based communication model. In what scenario is a persistent WebSocket connection preferred over traditional HTTP? [L4; CLO1] | 03 |
| 1(c) Analyze the architecture of an IoT Level 4 system. Explain why this level is specifically suited for noise monitoring in an urban area compared to lower IoT levels. [L5; CLO1] | 03 |
| 2(a) What are the core components of Network Function Virtualization (NFV) architecture? Briefly explain the role of the Management, Automation, and Network Orchestration (MANO) framework. [L2; CLO2] | 03 |
| 2(b) Illustrate the steps involved in managing an IoT device using the NETCONF-YANG protocol. How does the 'Rollback Manager' ensure system reliability during configuration changes? [L3; CLO2] | 03 |
| 2(c) Differentiate between Software Defined Networking (SDN) and traditional networking in the context of IoT. Argue how SDN enhances the scalability of large-scale IoT deployments. [L6; CLO2] | 04 |
| 3(a) What is ZigBee? Write down the types of ZigBee devices and the general characteristics of ZigBee standard. Also, describe the architecture of ZigBee. [L2; CLO2] | 07 |
| 3(b) Examine the role of the Link Layer in the IoT protocol stack. Compare the usage of IEEE 802.11 (Wi-Fi) and IEEE 802.15.4 (LR-WPAN) for indoor environment monitoring. [L3; CLO2] | 03 |
| 4(a) Describe the generic block diagram of an IoT device, highlighting the role of various I/O interfaces such as UART, SPI, and I2C. [L2; CLO3] | 05 |
| 4(b) Discuss cloud-based and edge/fog-based IoT architectures. Why are edge and fog computing important in modern IoT systems? [L5; CLO-5] | 05 |

Section B

There are **Four** questions in this section. Answer any **Three** questions.

- | | | |
|------|---|----|
| 5(a) | What is meant by control flow in Python? Identify the main types of statements used to control the flow of execution in a Python program. [L2; CLO-5] | 03 |
| 5(b) | An IoT weather monitoring system collects readings from different sensors, such as temperature, humidity, light intensity, and rain status. Each sensor reading should be stored with its corresponding sensor name. Which Python data structure do you think is appropriate for storing these data, and why? Create the data structure and show how the sensor readings can be stored in your chosen data structure. [L4; CLO-6] | 04 |
| 5(c) | Define variable scope. Describe the scope rules used in Python with suitable examples. [L1; CLO-6] | 03 |
| 6(a) | Define an IoT Platform as middleware. Explain how it facilitates the connection between remote hardware and user applications. [L1; CLO3] | 03 |
| 6(b) | What types of communication interfaces are available in Raspberry Pi? Compare SPI and I2C interfaces and discuss suitable scenarios for using each interface. [L4; CLO-6] | 04 |
| 6(c) | Compare Raspberry Pi, ESP32, and Jetson Nano development boards. [L4; CLO-6] | 03 |
| 7(a) | How is cloud platform used in IoT? [L2; CLO-7] | 02 |
| 7(b) | Describe the working principle and architecture of the MQTT protocol. [L2; CLO-7] | 04 |
| 7(c) | In which IoT scenarios can WAMP be a better choice than MQTT? Explain your answer with a real-life IoT implementation example. [L5; CLO-7] | 04 |
| 8(a) | Give a general description and implementation details of a smart waste management system. [L6; CLO-7] | 05 |
| 8(b) | What do you understand by a smart environment? Discuss the main features and services of key smart environments. [L5; CLO-7] | 05 |

Khulna University4th Year, 1st Term ExaminationSession: **2024-2025**

Electronics and Communication Engineering Discipline

Course No.: **CSE 4151**Full Title of Course: **Internet of Things**Full Marks: **60** Time: **03** Hours Credit: **3.0**

- * The figures in the margin indicate full marks. The questions are of equal value.
- * Use separate sheet for each section.

Section AThere are **Four** questions in this section. Answer any **Three** questions.

- | | |
|---|----|
| 1(a) Define the Internet of Things (IoT) and explain its five key characteristics. | 04 |
| 1(b) Compare IPv4 and IPv6 addressing schemes in the context of the massive scale of IoT devices.
Why is 6LoWPAN considered essential for low-power wireless networks? | 03 |
| 1(c) Evaluate the suitability of IoT Level 4 versus IoT Level 5 for a wide-area noise monitoring system.
Justify which level provides better scalability and why. | 03 |
| | |
| 2(a) Explain the fundamental differences between IoT and M2M communication. | 03 |
| 2(b) Analyze the 'Need for IoT Systems Management'. Discuss how automating configuration and monitoring operational data improves the overall performance of a multi-node IoT system. | 03 |
| 2(c) Differentiate between Software Defined Networking (SDN) and traditional networking in the context of IoT. Argue how SDN enhances the scalability of large-scale IoT deployments. | 04 |
| | |
| 3(a) Explain the specifications of the Zigbee protocol, including its operating frequency, data rate, and typical range. | 05 |
| 3(b) Explain the three-layer and five-layer IoT architectures. Briefly describe the function of each layer. | 05 |
| | |
| 4(a) Differentiate between a sensor and an actuator in an IoT system. Provide two examples of each found in an industrial environment. | 03 |
| 4(b) List the common power sources for IoT devices and explain the concept of Energy Harvesting. | 02 |
| 4(c) Design a power management strategy for a remote 'Forest Fire Detection' system (IoT Level 5) where manual battery replacement is not feasible. Evaluate the trade-offs between using high-capacity batteries versus solar energy harvesting. | 05 |

Section B

There are **Four** questions in this section. Answer any **Three** questions.

- 5(a) What are the major Python data types? Identify the appropriate data type for storing each of the following data in an IoT application: Raspberry Pi GPIO pin number, temperature value, humidity value, Wi-Fi SSID, and ON/OFF state. 03
- 5(b) A list is mutable, whereas a tuple is immutable. Explain this statement with suitable examples. 03
- 5(c) Explain the role of Big Data Analytics in IoT. How does data visualization (e.g., heat maps or flow diagrams) assist in making strategic decisions in retail analytics? 04
- 6(a) Differentiate between a module and a package in Python with suitable examples. 03
- 6(b) What types of communication interfaces are available in Raspberry Pi? Explain how Raspberry Pi can act as a bridge between the physical/device layer and the network/communication layer in an IoT architecture. 04
- 6(c) Compare Raspberry Pi, ESP32, and Jetson Nano development boards. 03
- 7(a) How is cloud platform used in IoT? 02
- 7(b) Describe the working principle and architecture of the MQTT protocol. 04
- 7(c) In which IoT scenarios can WAMP be a better choice than MQTT? Explain your answer with a real-life IoT implementation example. 04
- 8(a) Discuss the general applications of smart cities. 05
- 8(b) What is meant by a smart home? How can energy management, home safety, and security be achieved in smart homes? 05

Khulna University, Khulna
Electronics and Communication Engineering Discipline
Fourth Year First Term Examination, Session: 2024-2025
Course No.: ECE 4207 (R)

Full Title of the Course: **Optoelectronic Devices & Optical Communication**

Credit Hours: **3.00** Full Marks: **60** Time: **03 Hours**

- The figure in the margin indicates full marks. The questions are of equal value.
- Use separate sheet for each section.

SECTION A

There are **FOUR** questions in this section. Answer any **THREE** questions.

- 1(a) Discuss the basic components of an optical fiber communication system. Explain why optical fiber communication is suitable for long-distance and high-speed data transmission. 05
- 1(b) Define the relative refractive index difference for an optical fiber and show how it may be related to the numerical aperture. A step index fiber with a large core diameter compared with the wavelength of the transmitted light has an acceptance angle in air of 22° and a relative refractive index difference of 3%. Estimate the numerical aperture and the critical angle at the core-cladding interface for the fiber.
- 2(a) A multimode step index fiber has a relative refractive index difference of 1% and a core refractive index of 1.5. The number of modes propagating at a wavelength of $1.3 \mu\text{m}$ is 1100. Estimate the diameter of the fiber core. 04
- 2(b) A single-mode step index fiber has a core diameter of $7 \mu\text{m}$ and a core refractive index of 1.49. Estimate the shortest wavelength of light which allows single-mode operation when the relative refractive index difference for the fiber is 1%. 04
- 2(c) Describe what is implied by the term photonic crystal fiber (PCF) and explain the guidance mechanism for electromagnetic modes in such optical fibers. 02
- 3(a) Explain the concepts of attenuation and dispersion in optical fiber communication. Discuss the main causes of attenuation and the different types of dispersion. Also, explain how these impairments affect the performance of an optical fiber communication system. 05
- 3(b) When the mean optical power launched into an 8 km length of fiber is $120 \mu\text{W}$, the mean optical power at the fiber output is $3 \mu\text{W}$. Determine (i) the overall signal attenuation or loss in decibels through the fiber assuming there are no connectors or splices, (ii) the signal attenuation per km for the fiber, (iii) the overall signal attenuation for a 10 km optical link using the same fiber with splices at 1 km intervals, each giving an attenuation of 1 dB, (iv) the numerical input/output power ratio in (iii). 05
- 4(a) Describe with the aid of suitable diagrams three common techniques used for the mechanical splicing of optical fibers. Also, discuss the advantages and disadvantages of the fusion splicing technique compared with mechanical splicing. 05
- 4(b) Explain how the upstream and downstream traffic flow is managed and controlled within a Passive Optical Network (PON). 05

SECTION B

There are **FOUR** questions in this section. Answer any **THREE** questions.

- 5(a) For a LED, show that $P_{int} = \eta_{int} \frac{h\nu}{e\lambda}$, where symbols have their usual meanings. 05
- 5(b) A planar LED is fabricated from gallium arsenide which has a refractive index of 3.6. 05
- (i) Calculate the optical power emitted into air as a percentage of the internal optical power for the device when the transmission factor at the crystal-air interface is 0.68.
 - (ii) When the optical power generated internally is 50% of the electrical power supplied, determine the external power efficiency.
- 6(a) Describe the working principle of a DH laser, which has a stripe geometry. 05
- 6(b) A ruby laser contains a crystal length of 4 cm with a refractive index of 1.78. The peak emission wavelength from the device is 0.55 μm . Determine the number of longitudinal modes and their frequency separation. 05
- 7(a) Describe the working principle of an APD with necessary sketches. 05
- 7(b) An APD with a multiplication factor of 20 operates at a wavelength of 1.5 μm , calculate the quantum efficiency and the output photocurrent from the device if its responsivity at this wavelength is 0.6 A W^{-1} and 10^{10} photons of wavelength 1.5 μm are incident upon it per second. 05
- 8(a) Write short notes on 05
- (i) Optical power budget
 - (ii) OTDR
- 8(b) A digital optical fiber communication system operating at a wavelength of 1 μm requires a maximum bit-error-rate of 10^{-9} . Determine: (i) the theoretical quantum limit at the receiver in terms of the quantum efficiency of the detector and the energy of an incident photon; (ii) the minimum incident optical power required at the detector in order to achieve the above bit-error-rate when the system is employing ideal binary signaling at 10 Mbit s^{-1} , and assuming the detector is ideal. 05

Khulna University, Khulna
Fourth Year First Term Examination, Session: 2024-2025
Electronics and Communication Engineering Discipline
Course No.: 071409 ECE 4107
Full Title of the Course: Telecommunication Engineering
Full Marks: 60 Time: 03 Hours Credit: 03

- The figure in the margin indicates full marks. The questions are of equal value.
- Use separate sheet for each section.

SECTION A

There are **FOUR** questions in this section. Answer any **THREE** questions.

- | | |
|--|---|
| 1(a) Draw the pulse dialing waveform for the following number: 5421. [L- 1; CLO- 1, 2] | 3 |
| 1(b) In the Strowger exchanges, a call may be blocked even though an appropriate path exists. Explain how this can happen. [L- 3; CLO- 1, 2] | 3 |
| 1(c) Define telephone switching system and classify it with explanation. [L- 2; CLO- 1, 2] | 4 |
| 2(a) What is side tone? Explain the use of side tone in telecommunication. [L- 2; CLO- 1, 2] | 2 |
| 2(b) Describe the operation of an electromechanical rotary switch. [L- 3; CLO- 1] | 4 |
| 2(c) Explain selector hunter based access with figure in step-by-step switching. [L- 2; CLO- 1, 2] | 4 |
| 3(a) A 10,000 line exchange supports 2000 FS, 1000 SS and 1000 FF uniformly distributed. How many simultaneous calls can be put through the exchange? Also, determine the various design parameters. Cost for battery and antenna system are 10000 \$. Moreover, call set-up time is 2 ms for each stage (assume cost for uni-selector and two-motion selector are 10 \$ and 20 \$, respectively). [L- 4; CLO- 1, 2] | 5 |
| 3(b) Explain the principle of a 4×4 crossbar switching. [L- 3; CLO- 1, 2] | 5 |
| 4(a) Sketch and explain the operation of load sharing mode. [L- 2; CLO- 1, 2] | 3 |
| 4(b) For TSSST switches, derive the expressions: $\text{Complexity} = N_x + (N_{BX} + N_{BT} + N_{BTC})/100$ where the symbols have their usual meanings. [L- 4; CLO- 1, 2] | 4 |
| 4(c) Given that MTBF = 500 hours and MTTR = 3 hours, determine the unavailability for single and dual processors system for 30 years period. [L- 1, 2; CLO- 1, 2] | 3 |

SECTION B

There are **FOUR** questions in this section. Answer any **THREE** questions.

- | | |
|--|----|
| 5(a) Define busy hour and time consistent busy hour. Explain with example. [L- 1,2; CLO-1] | 03 |
| 5(b) Define Erlang Traffic. Derive and analyze the relationship between Grade of Service (GOS) and blocking probability in Erlang loss systems. [L- 3, 4; CLO- 1, 2] | 04 |
| 5(c) Suppose the Khulna Telephone Exchange has 10,000 subscribers. During a 25-minute observation period, 50 subscribers initiated calls, but only 40 calls were successful. The total duration of the successful calls was 5400 seconds. Calculate the load offered to the network by the subscribers. Also determine the Grade of Service (GoS). [L- 4, 5; CLO- 2,3] | 03 |
| 6(a) Define signaling and classify it. Compare in-channel and common channel signaling in telecommunication by writing four differences. [L- 2, 3; CLO- 1] | 05 |
| 6(b) Define and explain SS7 signaling. Discuss different signaling points in SS7 signaling networks with the necessary block diagram. [L- 2, 3; CLO- 1] | 05 |
| 7(a) Define Engest traffic. In this case, determine the relation between GoS and PR. The symbols have their usual meanings. [L- 1, 4; CLO- 1, 3] | 04 |
| 7(b) Define Signal Unit. Write the names of different types of signal unit. [L- 1; CLO- 1] | 03 |
| 7(c) Describe the basic functions of SIP (Session Initiation Protocol) and RTP (Real-time Transport Protocol) for IP telephony. [L- 2; CLO- 1, 4] | 03 |
| 8(a) Compare VoIP and IP telephony. Draw the functional block diagram of IP telephony and explain each block. [L- 2, 3; CLO- 2, 4] | 05 |
| 8(b) Suppose, in tele-traffic analysis, $P_{10}(6) = 0.8$. Interpret the meaning of this probability. The symbols have their usual meaning. [L- 2, 3; CLO- 3] | 02 |
| 8(c) Compare circuit switching and packet switching with examples. [L- 2; CLO- 1, 3] | 03 |