

Time: 2 $\frac{1}{2}$ hrs.

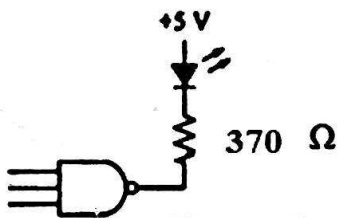
M. M.: 75

N.B.:

1. All questions are compulsory.
2. Figures to the right indicate full marks.
3. Draw neat diagrams wherever necessary.
4. Symbols have usual meaning unless otherwise stated.
5. Use of non-programmable calculator is allowed.

1. (a) Attempt any one: -
 - (i) With a neat diagram explain the construction of SCR. With the help of equivalent circuit, explain the working of SCR. Draw I - V characteristics. 10
 - (ii) Explain construction and working of Unijunction transistor (UJT). Draw and explain I - V characteristics of UJT. Explain peak point and valley point. 10
- (b) Attempt any one: -
 - (i) Explain use of JFET as voltage controlled resistor. 5
 - (ii) The data sheet of a JFET gives the following information: $I_{DSS} = 3 \text{ mA}$, $V_{GS(0ff)} = -6 \text{ V}$ and $g_m(\text{max}) = 5000 \mu\text{S}$. Determine the transconductance for $V_{GS} = -4 \text{ V}$ and find drain current I_D at this point. 5
2. (a) Attempt any one: -
 - (i) Define Differential Amplifier. 10
Draw a circuit of an emitter coupled differential amplifier having double ended input and balanced/double ended output. Using DC analysis derive an expression for I_C and V_{CE} .
 - (ii) With the help of circuit diagram, derive the expression for logarithmic amplifier using OPAMP output voltage. 10
Calculate the output of log Amplifier constructed using OPAMP, for an input of 250 mV. Given $R_i = 1 \text{ k}\Omega$, $k = 1.38 \times 10^{-23} \text{ J/K}$, $q = 1.6 \times 10^{-19} \text{ C}$, $T = 300 \text{ K}$ and $I_s = 0.05 \mu\text{A}$.
- (b) Attempt any one: -
 - (i) For double ended input and single ended output circuit: $V_{CC} = 12 \text{ V}$, $V_{EE} = -12 \text{ V}$, $R_{C1} = R_{C2} = 10 \text{ k}\Omega$, $R_E = 10 \text{ k}\Omega$ and $V_1 = V_2 = 0 \text{ V}$. Calculate collector current in each transistor. Also calculate tail current and output voltage. 5
 - (ii) With the help of circuit diagram, explain Window Comparator. 5
3. (a) Attempt any one: -
 - (i) Draw a neat circuit diagram of a transistorized astable multivibrator. With the help of necessary waveforms explain its working and derive an expression for frequency of output wave. 10
 - (ii) Draw the circuit diagram of a pulse width modulator using IC 555 timer. Explain its working. Draw the circuit diagram of a pulse position modulator using IC 555 timer. 10
- (b) Attempt any one: -
 - (i) With the help neat circuit diagram, explain the working of series voltage regulator using two transistors. 5
 - (ii) In an astable multivibrator using IC 555 timer $R_A = R_B = 3.3 \text{ k}\Omega$ and $C = 0.01 \mu\text{F}$. Find the frequency of oscillation and duty cycle. 5

4. (a) Attempt any one: -
- (i) Explain two - input Transistor Transistor Logic NAND gate. **10**
 - (ii) Explain benefits of digital transmission. **10**
- (b) Attempt any one: -
- (i) Explain current sinking and current sourcing in CMOS. **5**
 - (ii) An information signal to be transmitted digitally is a rectangular wave with a period of 85.0 μ Sec. It has been determined that the wave will be adequately passed if the bandwidth includes the fourth harmonic. Calculate the signal frequency, the fourth harmonic and, Minimum sampling frequency. **5**
5. Attempt any Five: -
- (i) Determine the maximum and minimum peak-point voltage for a UJT with $V_{BB} = 25$ V. Given that UJT has a range of $\eta = 0.74$ to 0.86 . **3**
 - (ii) For a certain D-MOSFET, $I_{DSS} = 10$ mA and $V_{GS(off)} = -8$ V. **3**
 - (i) Calculate I_D at $V_{GS} = -3$ V.
 - (ii) Calculate I_D at $V_{GS} = +3$ V.
 - (iii) In an active first order low pass filters using operational amplifier, $R = 2.2$ k Ω and $C = 0.033$ μ F. What is the cut-off frequency? **3**
 - (iv) In an Astable multivibrator using OPAMP if $\beta = 0.7$ and $R = 10$ k Ω then find the value of capacitor used to get a pulse at a rate of 3 kHz. **3**
 - (v) A pulse of 2 μ sec duration is used to trigger the transistorized monostable multivibrator which uses $R_{C1} = R_{C2} = 3$ k Ω , $R_{B1} = 80$ k Ω , $C_1 = 0.01$ μ F. Calculate the length of the output pulse. **3**
 - (vi) A ramp generator using IC 555 has $V_{CC} = +12$ V, $V_{BE} = 0.7$ V, $R_E = 10$ k Ω , $R_1 = 5$ k Ω , $R_2 = 10$ k Ω and $C = 0.47$ μ F. Calculate capacitor current. **3**
 - (vii) A TTL circuit drives an LED. When the TTL output is high, the LED is dark. When the TTL output is low, the LED lights up. If the LED voltage drop is 1.8 V, Calculate LED current for a low TTL output. **3**



- (viii) The input voltage of a compander with a maximum voltage range of 1 V and a μ of 255 is 0.25. What are the output voltage and gain? **3**

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1. (a) Attempt any one: -

- (i) Derive the equation of motion for a particle in an inverse square field and show that its trajectory is a conic section. Determine the eccentricity and the condition for an elliptical orbit. 10
- (ii) Derive an expression for Coriolis theorem and interpret each term in the expression. 10

(b) Attempt any one: -

- (i) What are Kepler's laws of planetary motion? Give the proof of Kepler's first and second law. 5
- (ii) Show that the centrifugal acceleration contribution to g_e (effective gravitational acceleration) is less than 0.3% of g . (Given $R_E = 6378$ km) 5

2. (a) Attempt any one: -

- (i) Derive the Lagrange's equation of motion from D'Alembert's principle for conservative forces. 10
- (ii) Consider a mass m moving on a plane and acted upon by force, $\frac{-k}{r^2}$. Obtain the equation of motion of the particle using Lagrangian formalism. 10

(b) Attempt any one: -

- (i) Write a short note on Generalized coordinate. 5
- (ii) Derive the Lagrange's equation of motion for Atwood's Machine. 5

3. (a) Attempt any one: -

- (i) For a fluid moving with velocity \vec{v} , show that; 10

$$\frac{d}{dt} = \frac{\partial}{\partial t} + \vec{v} \cdot \nabla$$
 Hence obtain the equation of continuity.
- (ii) Explain how Euler angles are used to specify the orientation of a rigid body. Set up Lagrangian for a heavy symmetric top in terms of Euler angles. 10

(b) Attempt any one: -

- (i) An incompressible fluid is moving horizontally through a pipe of non-uniform cross section. If A_1 and A_2 are the cross sectional areas where the velocities are v_1 and v_2 and pressures P_1 and P_2 respectively, then show that; 5

$$v_1 = A_2 \sqrt{\frac{2(P_2 - P_1)}{\rho(A_2^2 - A_1^2)}}$$

for steady flow.

- (ii) Consider a uniform square plate in $x - y$ plane. The co-ordinates of the corners of the plate are $(0, 0, 0)$, $(a, 0, 0)$, $(0, a, 0)$ and $(a, a, 0)$. Find the moments of inertia and products of inertia and hence inertia tensor of the plate. 5

4. (a) Attempt any one: -

- (i) An anharmonic oscillator of mass m is subjected to a conservative force $F(x) = -k(x + \alpha x^3)$ 10

Illustrate and explain graphically the potential energy for the hard and soft springs by using $k = \pm 1$ and $\alpha = \pm 1$

- (ii) What is logistic map? Using this map obtain the equation for the slope of the tangent drawn at a fixed point and hence explain the stability of the fixed points for 1) $0 < \lambda < 1$ 2) $1 < \lambda < 3$ and 3) $3 < \lambda < 4$. 10

(b) Attempt any one: -

- (i) Discuss the chaotic behavior of Lyapunov exponent. 5

- (ii) Two very close initial values of x on logistic map are 0.40000 and 0.40001 respectively. With $\lambda = 4$ after 15 iterations the values are 0.13561 and 0.00180 respectively. Calculate Lyapunov exponent. 5

5. Attempt any Five: -

- (i) If the eccentricity of a planet's orbit about the sun is 0.2 find the ratio of the lengths of the major axis to the minor axis of the orbit of the planet. 3

- (ii) If a body of mass 1 kg is moving with a velocity of 100 m/s, estimate the maximum Coriolis force experienced by the body. Given: $T = 1$ day. 3

- (iii) What is virtual work? 3

- (iv) What is degree of freedom? State degree of freedom of a particle moving freely in space. 3

- (v) A liquid of density 10^3 kgm^{-3} , is flowing through a horizontal pipe of varying cross sectional areas. At point A, the pressure $P_A = 1600 \text{ Nm}^{-2}$ and the velocity $v_A = 0.5 \text{ ms}^{-1}$. What will be the velocity of the liquid at point B? where $P_B = 10^3 \text{ Nm}^{-2}$. 3

- (vi) The angular velocity of a rotating rigid of mass 'M' about some axis is given by; $\vec{\omega} = 3\hat{x} - 2\hat{y} - 6\hat{z}$ and its moment of inertia tensor is given by; 3

$$I = Ma^2 \begin{pmatrix} 1 & -3 & 1 \\ -3 & 2 & 5 \\ 1 & 5 & 2 \end{pmatrix}$$

Compute the angular Momentum of the body.

- (vii) Write note on Henon Map. 3

- (viii) Find the fractal dimension of a line of length l in a plane. 3

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5. Use of non-programmable calculator is allowed.

1. (a) Attempt any one: -
 - (i) What is Lorentz Fitzgerald contraction hypothesis? How does it explain the negative result of Michelson-Morley experiment? Then why was it discarded? 10
 - (ii) State the basic postulates of special theory of relativity. Obtain the Lorentz transformation of space and time stating clearly where and how the postulates are used. 10
- (b) Attempt any one: -
 - (i) A meter stick is projected into space at such a speed that its length appears contracted to 50 cm. Find out the speed of the stick. 5
 - (ii) What is mean life of meson travelling with a speed $0.7c$ if proper mean life is 3×10^{-8} sec. 5
2. (a) Attempt any one: -
 - (i) Derive Lorentz transformation equations for components of acceleration. 10
 - (ii) What is twin paradox? Explain the resolution of twin paradox. Draw space-time diagram of twin paradox. 10
- (b) Attempt any one: -
 - (i) Using Minkowski's space time continuum explains relativity of simultaneity. 5
 - (ii) A source of light emitting light of wavelength 7000 \AA is moving along the circumference of a circle with a constant speed of $0.6c$ relative to an observer fixed at the centre of the circle. Find the wavelength of light as observed by the observer. 5
3. (a) Attempt any one:-
 - (i) Show that the mass of a particle moving with a speed u is to be defined by 10

$$m = \frac{m_0}{\sqrt{1 - \frac{u^2}{c^2}}}$$
 - (ii) Consider two inertial frames S and S' where S' is moving uniformly with velocity v along x - axis with respect to rest frame S . Two identical bodies of equal mass m_0 having same kinetic energy K undergoes inelastic collision and stick together after collision in frame S' . 10
 - a) Show that the total energy remains conserved in both frame S and S' .
 - b) Show that the relativistic mass remains conserved in both frame S and S' .
- (b) Attempt any one:-
 - (i) Derive the relation for a particle, $E^2 = p^2 c^2 + m_0^2 c^4$. 5
 - (ii) State the expression of acceleration in terms of force in relativity. Explain the concept of longitudinal mass and transverse mass. 5

4. (a) Attempt any **one**:-
- (i) Derive the transformation equation for electric field \vec{E} using Lorentz transformation equation for force. **10**
 - (ii) Show that the Maxwell's equations of electrodynamics are invariant under Lorentz transformation. Assume that $\text{div } \vec{B} = 0$ is invariant. **10**
- (b) Attempt any **one**:-
- (i) State the postulates of General theory of relativity and explain principle of equivalence. **5**
 - (ii) Derive the expression for the resultant force experienced by two equal charges moving along positive x-direction. **5**
5. Attempt any **Five**:-
- (i) Using Galilean transformation equation for space, show that the distance between the two points is invariant under Galilean transformations. **3**
 - (ii) A spaceship is travelling at a speed of $0.75c$. Find the contraction of length observed as a fraction of its proper length. **3**
 - (iii) Using Lorentz transformation equations derive the Einstein's law of velocity addition. **3**
 - (iv) A source of light of wavelength 6000 \AA is receding from an observer with a speed of $0.6c$. Find the wavelength of light as observed by the stationary observer. **3**
 - (v) Find the mass and kinetic energy of photon of wavelength 5000 \AA . Take Planck's constant $h = 6.63 \times 10^{-34} \text{ Js}$. **3**
 - (vi) Calculate the velocity of a particle when its total energy is two times its rest energy. **3**
 - (vii) A sphere has charge density of 2 C/m^3 . If sphere moves with velocity $0.8c$, calculate the volume current density of the sphere. **3**
 - (viii) A steady charge placed at 'O' in S' frame has electric field 0.1 V/m w.r.t. S frame at time $t = 0$. If the S' frame moves with velocity $0.6c$ along the positive x-direction, find out the electric field parallel to the direction of motion. **3**

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Constants: Boltzmann Constant: $1.380649 \times 10^{-23} \text{ m}^2 \text{ kg s}^{-2} \text{ K}^{-1}$
 Planck's Constants: $6.64 \times 10^{-34} \text{ Js}$

1. (a) Attempt any one: -
 - (i) Explain Gamow's theory of alpha decay. **10**
 - (ii) What is beta decay? Derive the energy conditions under which different types of beta decay can take place. **10**
- (b) Attempt any one: -
 - (i) Explain the terms: a) Range b) Straggling with respect to alpha decay. **5**
 - (ii) ${}^7_3\text{Li}$ and ${}^7_4\text{Be}$ have atomic masses 7.016005 u and 7.016929 u. Which of them show β activity and of what type? **5**
2. (a) Attempt any one: -
 - (i) With proper experimental arrangement, explain the Mossbauer effect in detail. **10**
 - (ii) What are the similarities between a nucleus and a drop of liquid? Write the successes and limitations of the Liquid Drop Model. **10**
- (b) Attempt any one: -
 - (i) What is γ -decay? Write the selection rules for γ emission. **5**
 - (ii) For the isobaric families with $A = 45$ estimate the nuclear charge Z_0 for the most stable isobar. **5**

Given: $a_n = 19 \text{ MeV}$, $a_c = 0.60 \text{ MeV}$, $M_n = 939.57 \text{ MeV}$, $M_p = 938.78 \text{ MeV}$
3. (a) Attempt any one: -
 - (i) Explain the principle, construction and working of a proton synchrotron. **10**
 - (ii) Describe the neutron cycle in a thermal nuclear reactor and show how it leads to the four factor formula. **10**
- (b) Attempt any one: -
 - (i) Give an account of distribution of energy released in the fission of ${}^{235}\text{U}$ nucleus. **5**
 - (ii) A betatron of 100 MeV energy has a stable radius of 0.84 m. calculate the value of magnetic field intensity at the orbit for this energy. **5**

4. (a) Attempt any one: -
- (i) Discuss the meson theory of nuclear forces using suitable Feynman diagrams. Also explain Yukawa potential. **10**
 - (ii) What are bosons and fermions? Give classification of elementary particles in terms of bosons and fermions. **10**
- (b) Attempt any one: -
- (i) Write the basic properties of electrons and positrons. **5**
 - (ii) Show that lepton number and baryon number is conserved in case of neutron to proton conversion through (β^-) decay. **5**
5. Attempt any Five: -
- (i) Alpha particles having kinetic energy of 8.776 MeV. Calculate the velocity of alpha particle?
Given : mass of alpha particle = 6.67×10^{-27} Kg. **3**
 - (ii) K^{40} decays to Ar^{40} by electron capture. Assuming that the initial kinetic energy of the electron and the recoil energy of the nucleus is zero, calculate the kinetic energy of the neutrino. **3**
 - (iii) Considering symmetric fission. Calculate the energy released by fission when a parent nuclide is $^{120}_{52}Te$.
Given: $a_c = 0.71$ MeV, $a_s = 17.8$ MeV. **3**
 - (iv) Find the ratio of average surface energies of $^{27}_{13}Al$ and $^{64}_{30}Zn$. **3**
 - (v) Calculate the amount at energy available if 10 gram of $^{235}_{92}U$ is completely fissioned given that the energy released per fission of U^{235} is 200 MeV. **3**
 - (vi) A cyclotron with Dee's of diameter 1.8 m has a magnetic field of 0.8 tesla. Calculate the energy to which the double ionized helium ion He^{++} can be accelerated. Mass of $He^{++} = 6.68 \times 10^{-27}$ kg. **3**
 - (vii) Using Heisenberg's Uncertainty principle, estimate the mass of the exchanged particle if the 'range' of the potential is 10^{-15} m?
(Given: $\hbar = 1.054571 \times 10^{-34}$ J-s.) **3**
 - (viii) Write short note on mesons. **3**

250423

SAC1625

RIZVI COLLEGE OF ARTS, SCIENCE AND COMMERCE
(University of Mumbai)

T.Y.B.Sc. (PHYSICS)

SEM - VI

Time : 08:00 AM to 10:30 AM

ELECTRONIC INSTRUMENTATION - II. (USACE1602)
(2 ½ Hours)

Total Marks : 75M

Date : 23 / 04 / 2025

- N.B. : (1) All questions are compulsory.
(2) Draw neat diagrams whenever necessary.
(3) Figures to the right indicate full marks.
(4) Use of log table or non-programmable calculator is permitted.

Q.1) Attempt any **TWO** questions . (15M)

- (i) What do you mean by an encoder? Explain the functioning of IC 74148 encoder.
- (ii) $F(A,B,C,D) = \sum m(0,1,2,3,5,6,8,10,15)$ Draw K-Map and find minimized Boolean expression along with circuit diagram.
- (iii) With the help of truth table and K – maps, design BCD to excess – 3 converter.

Q.2) Attempt any **TWO** questions . (15M)

- (i) Explain Stack with their PUSH and POP instructions.
- (ii) Explain block diagram of 8255A PPI with their control logic and Input – Output ports.
- (iii) Write subroutine program for 8085, to calculate $n!$. Get value 'n' from C200H.

Q.3) Attempt any **TWO** questions . (15M)

- (i) Draw the pin diagram of 8051 Microcontroller (μ_c) and explain their each and every pin.
- (ii) Write and explain various addressing modes of 8051 Microcontroller program (μ_c).
- (iii) Define all four rotate instructions (RL, RLC, RR & RRC) with their example in (μ_c).

Q.4) Attempt any **TWO** questions . (15M)

- (i) Write briefly on various operators used in C++.
- (ii) Explain Inline function and write down their disadvantages.
- (iii) Write the structure of *do-while-loop* with one related program in C++ programming.

Q.5) Attempt any **FIVE** questions. (Each question carry 03 Mark) (15M)

- (i) What are tri-state devices? Explain the tri-state switch.
- (ii) What are multiplexers? How will you realize the 4:1 multiplexer?
- (iii) Differentiate between CALL and RET .
- (iv) Describe the bidirectional buffer.
- (v) Differentiate between RISC and CISC.
- (vi) Write down about arithmetic if operator.
- (vii) Spot the errors in the following C++ statement and write them correctly.
(a) `include<iostream.h>` (b) `for (M=1, M \geq 10, M--)` (c) `Cin >> a << b`
(d) `(X > 35 and X \leq 50)` (e) `Cout >> Learning C++ is easy;`

_____ × _____ END _____ × _____

C. Match the column: (Any five)

- | | |
|-------------------------------------|---|
| a. Salt bridge | i. $\eta_{rel} - 1$ |
| b. Concentration cells | ii. $C - P - 2$ |
| c. Specific Viscosity | iii. Need of Photoelectric effect |
| d. 'F' is | iv. Minimization of liquid junction potential |
| e. Threshold frequency of radiation | v. $E^0 = 0$ |
| f. AlN | vi. $E^0 \neq 0$ |
| g. Spin angular momentum | vii. Minute bar magnet |
| h. Spinning nucleus | viii. Binary semiconductor |
| | ix. $\sqrt{I(I+1)} \cdot h/2\pi$ |
| | x. Pure semiconductor |

