DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

3RD YEAR BED. TECHNOLOGY (EEE), BSC. ELECTRICAL AND ELECTRONIC ENGINEERING & BSC. TELECOMMUNICATION AND INFORMATION ENGINEERING

EEE/ETI 3209 ANALOGUE ELECTRONICS II CAT 1

TIME: 1 HOUR

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a) With the aid of a well labeled diagram of a *current-shunt feedback* circuit, explain the principle of negative current feedback. [5 Marks]

b) Derive the expression for the *collector efficiency* of a power amplifier. [5 Marks]

c) Using a well-labeled sketch of a *negative voltage feedback amplifier*, derive an expression for the gain with feedback (A_{vf}). [5 Marks]

d) An amplifier with negative feedback has a voltage gain of 100. It is found that without feedback, an input signal of 50 mV is required to produce a given output, whereas with feedback, the input signal must be 0.6 V for the same output. Calculate

i. gain without feedback [3 Marks]

ii. feedback fraction. [3 Marks]

e) Fig. Q(e) shows a negative feedback amplifier. If the gain of the amplifier without feedback is 105 and R1 = 100 Ω, R2 = 100 kΩ, find;

i. Feedback fraction [2 Marks]

ii. Gain with feedback. [2 Marks]

iii. Output voltage if input voltage is 5 mV. [2 Marks]

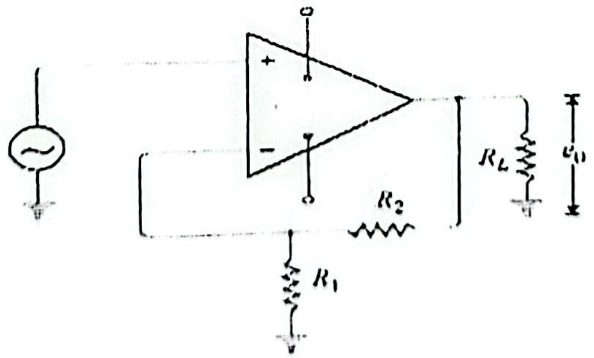

Fig. Q(e)

f) The total thermal resistance of a power transistor and heat sink is 20°C/W. The ambient temperature is 25°C and $T_{J\,max} = 200°C$. If $V_{CE} = 4$ V, find the maximum collector current that the transistor can carry without destruction. [3 Marks]

CAT 1 EEE EEE 3208/ETI 3208 EMIII Oct. 23, 2024.

Q1. A TEM electromagnetic wave of E= 0.1 V/m peak, propagates through a lossless medium having relative values of μ=1 and ε=78 at f= 300MHz. Obtain the values of β, λ, η and υ of the wave in the given medium. Symbols carry the usual meaning.

Q2. State Maxwell's equations for time-varying fields and explain the physical significance of each equation in i) Differential form and ii) Integral form iii) State the constitutive parameters that relate to the four Maxwell's equations.

Q3. i)Starting from Maxwell's two curl equations for free space obtain a three-dimensional wave equation in E. Assume harmonic variation of fields. ii) Assuming the value of γ, Obtain formulae of α and β.

Q4. i) Differentiate between the terms 'conduction' and 'displacement' current densities.
ii) Prove that for harmonic variation of E field, displacement current density= $j\omega\varepsilon E$. iii) Show that the displacement current in the dielectric of a parallel plate capacitor is equal to the conduction current in its leads.

Q5. An electromagnetic wave in the air is incident normally on a dielectric boundary. i) Derive formulae for reflection and transmission coefficients for both fields. ii) Given that the electric field in the air is 1.5mV/m and $\mu_r = 1$ & $\varepsilon_r = 4$ for other mediums, Find values of reflected and transmitted E and H fields

DKUT, EEE DEPARTMENT,
IEEE, TIE & B.ED(EET) YEAR III
EEE/ETI 3206 DIGITAL ELECTRONICS II CAT II

1). For the FSM in Figure 2 below representing a Moore Vending Machine system

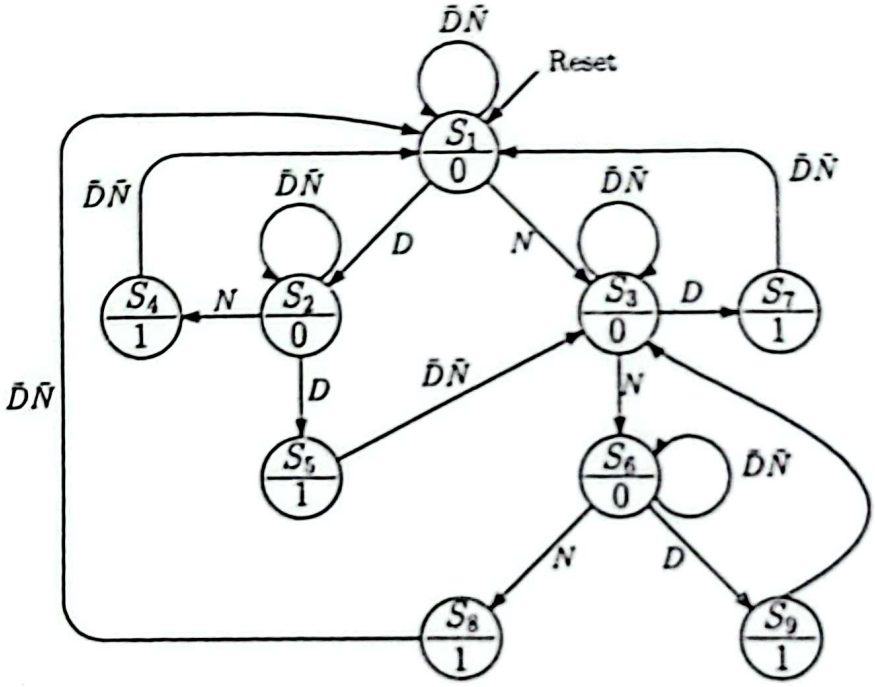

Figure 2: FSM of a Vending Machine system

(i) Generate the state table of the system 1 Mark

(ii) Using partition tables or otherwise, minimize the system states 2 Marks

(iii) Draw the minimized state diagram 2 Marks

(iv) Draw the equivalent Moore and Mealy machine of the minimized system 2 Marks

(v) Using D-FF, realize the system 4 Marks

2). Draw the VHDL entity of the of the system and write entity section of the VHDL code for the system. 4 Mark

CAT 2 EM III EEE3208 DEC. 2024

Q1.a) i) Define the word 'uniform plane wave' in free space

ii) Differentiate between the terms 'conduction' and 'displacement' current densities.

iii) Prove that for harmonic variation of E field, displacement current density= jωεE.

iv) State units of each symbol in the formula in (iii) above.

iv) Show that the displacement current in the dielectric of a parallel plate capacitor is equal to the conduction current in its leads. Q1. b) i) Derive Maxwell's equations for time-varying fields in Differential form ii) explain the physical significance of each of Maxwell's equations in Integral form (iii) State the constitutive parameters that relate to the four Maxwell's equation Q2.a) Starting from Maxwell's two curl equations for free space obtain a three-dimensional wave equation in either E OR H. Assume harmonic variation of fields. Q2.b) i) Electric field vector in free space of a plane uniform wave is given as $E_x = 12Sin(\omega t - \beta Z)$ V/m. The other two components are zero, i) Show that the electromagnetic wave travels in a positive 'z' direction.

ii) Using Maxwell's curl equation obtain the 'H' field. iii) Hence show that $E/H = \sqrt{\mu/\epsilon}$.

Q3a) Assuming the general value of γ the propagation constant of electromagnetic waves, i) Obtain formulae for α and β. ii) State units of α and β. Q3.b) i) Obtain the values of free space η and velocity for electromagnetic waves. ii) A plane uniform electromagnetic wave with a peak value of electric field intensity of 25 V/m is traveling in free space. Find average power crossing a circular area of radius 2 meters normal to the direction of travel. iii) Show that α=β=1/δ for a good conductor.

Q.4 Energy transfer by electromagnetic waves as given by the following equation. i) Explain the physical significance of each term in this equation. ii) Give a word statement of Poynting's theorem. iii) State units of Poynting's vector and explain how it is useful in specifying the direction of propagation.

$$\iiint \sigma E^2 dv + \frac{\delta}{\delta t}\iiint \left(\frac{\varepsilon E^2}{2} + \frac{\mu H^2}{2}\right)dv + \iint \left(E \times H\right) \bullet ds = 0$$

Q5. a) Assuming the value of γ, the propagation constant, Prove the following approximations for wave propagation in good conductors I) Magnitude of attenuation and phase constants are equal. ii) Velocity is given by the formula: $v^2 = 2\omega/\mu\sigma$ and III) η=Jωμ/γ for any medium

(b) Define the f terms Surface impedance and Skin depth for a good conductor

(c) Determine the depth of penetration and the surface resistance for copper at 5 MHz. Given that the conductivity of copper is 58 MS/m and its relative Permeability is unity.

SMA 3261 Numerical Methods – CAT 1 (5th December 2024) – EEE

1. Using Lagrange's formula, find a cubic polynomial which approximate the following data: (3,1), (4,2), (5,4) and (7,11). (5 Marks)
2. Find $y = e^{3x}$ for $x = 0.05$ using Newton forward difference formula and the data in the following table. (Correct to 5 decimal places) (5 marks)

x	0	0.1	0.2	0.3	0.4
y	1	1.3499	1.8221	2.4596	3.3201

3. Using Newton General divided formula, find $f'(8)$ from the data in the table below. (5 Marks)

x	4	5	7	10	11
$f(x)$	48	100	294	900	1210

4. Use Stirling's formula to find the value of $f(3.52)$ from the following data. (5 Marks)

x	3.3	3.40	3.50	3.60	3.70	3.80
$f(x)$	0.303030	0.294118	0.285714	0.277778	0.270270	0.263158

SMA 3261: Numerical Methods – CAT II (18th Dec 2024) – EEE

1. Using Newton-Raphson's method find the solution of $e^x = 3.5x$ in the interval $(0,1)$ correct to 5 decimal places.
(5 Marks)

2. Evaluate $\int_1^2 \int_2^3 \frac{dxdy}{x+y}$ using Trapezoidal rule. Take $h = k = 0.25$ where $h = x_{n+1} - x_n$ and $k = y_{m+1} - y_m$.
(5 Marks)

3. Taking $h = 0.8, 0.4, 0.2, 0.1$ and working with 5 decimal places, use Romberg's formula to evaluate $\int_0^{0.8} e^{-x^2} dx$ correct to 4 decimal places.
(10 Marks)

SMA 3261: Numerical Methods – CAT III (10th Jan 2025) – *EEE (4.00pm)*

1. Use 4^{th} order Taylor method to compute $y(0.1)$, correct to 5 decimal places, given that $y' = xy^2 + 1, y(0) = 1$. (5 Marks)
2. Use Runge-Kutta method of order four with $h = 0.2$ to find an approximate value of $\frac{dy}{dx} = \sqrt{x+y}$, with $y(0.4) = 0.41$ at $y(0.6)$. Work with 5 decimal places. (5 Marks)
3. Given the $\frac{dy}{dx} = (y^2 + xy^2)/2$, $y(2) = 1$, $y(2.1) = 1.1799$, $y(2.2) = 1.4493$ and $y(2.3) = 1.8957$, find $y(2.4)$ using three iterations of ABM predictor-corrector method. (10 Marks)

DEDAN KIMATHI UNIVERSITY EXAMINATION 2024/2025

THIRD YEAR SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING

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BACHELOR OF EDUCATION IN TECHNOLOGY (ELECTRICAL AND ELECTRONIC ENGINEERING)

EEE 3207 ELECTRICAL MACHINES II

DATE: 22/01/2025 **TIME: 2-4 PM**

Instructions

This examination paper contains **FIVE** questions. Attempt **compulsory QUESTION ONE** and **any other TWO** questions.

QUESTION ONE 30 MARKS (Compulsory)

a) What are the common types of three-phase transformer winding connections? **(4 marks)**

b) What is the basic principle of operation of a three-phase induction motor? **(5 marks)**

c) A 400 V, 50 Hz, three-phase induction motor has a rotor impedance of (0.5+j4.0) Ω referred to the stator. If the rotor is running at a slip of 5%, calculate the rotor current at full load. **(6 marks)**

d) Describe how a three-phase transformer can be built. **(3 marks)**

e) List at least four Conditions for parallel operation of transformers. **(4 marks)**

f) A 2MVA transformer (A) is connected in parallel with a 4MVA transformer (B) to supply a 3 phase load of 5000kVA at 0.8 p.f. lagging. Determine the kVA supplied by

each transformer assuming equal no-load voltages. The % voltage drops in the windings at their rated loads are as follows:

Transformer A:	resistance 2%	reactance 8%	
Transformer B:	resistance1.6%	reactance 3%	**(8 marks)**

QUESTION TWO 20 MARKS

a) What is the significance of transformer vector groupings? **(3 marks)**

b) Describe using a diagram the following transformer vector grouping giving advantage and disadvantage of each.

   a. Dd6 **(4 marks)**

   b. Yy0 **(4 marks)**

   c. Yd11 **(4 marks)**

c) A three-phase induction motor has a slip of 3% when running at full load. If the motor's synchronous speed is 1200 RPM, calculate the full-load rotor speed. **(5 marks)**

QUESTION THREE 20 MARKS

a) How do harmonics affect the performance of a three-phase transformer? **(3 marks)**

b) Explain the equivalent circuit of a three-phase induction motor. **(4 marks)**

c) What are the common methods of starting a three-phase induction motor? **(6 marks)**

d) The maximum torque of a 440 V, three phase four-pole 60 Hz induction motor is 400 Nm at a difference (slip) between synchronous and non- synchronous speeds of 0.1. If the supply frequency is changed to 50 Hz and the voltage is reduced to 400 V, what will be the maximum torque generated and difference between the synchronous and non-synchronous speed (slip), respectively? **(7 marks)**

QUESTION FOUR 20 MARKS

a) What are the key considerations when paralleling transformers? **(5 marks)**

b) What are the different methods of braking used in three-phase induction motors?

(5 marks)

c) A 5 HP, 400 V, three-phase induction motor has a full-load efficiency of 85% and a power factor of 0.88. Calculate the full-load line current. **(5 marks)**

d) A three-phase induction motor has a slip of 10% when running at full load. If the motor's synchronous speed is 600 RPM, calculate the full-load rotor speed.

(5 marks)

QUESTION FIVE 20 MARKS

a) List four applications of three-phase transformers? **(3 marks)**

b) What are the methods of speed control in three-phase induction motors? **(4 marks)**

c) Two transformers, each rated at 1000 kVA, have impedances of 5% and 7%, respectively. What is the load each transformer carries when they are paralleled and connected to a total load of 1500 kVA? **(4 marks)**

d) A 400 V, 50 Hz, 4-pole, three-phase induction motor is running at 1440 RPM. Calculate:

i. The synchronous speed **(3 marks)**

ii. The slip **(3 marks)**

iii. The rotor frequency **(3 marks)**

DEDAN KIMATHI UNIVERSITY OF TECHNOLOGY
UNIVERSITY EXAMINATION 2024/2025

THIRD YEAR SECOND SEMESTER EXAMINATION FOR
THE DEGREE OF BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING
&
THE DEGREE OF BACHELOR OF EDUCATION IN TECHNOLOGY (ELECTRICAL AND ELECTRONIC ENGINEERING)
&
THE DEGREE OF BACHELOR OF TELECOMMUNICATION AND INFORMATION ENGINEERING

EEE/ETI 3211 ELECTROMAGNETICS III

DATE: 20/01/2025 TIME: 11.00-01.00 PM

Instructions:
This examination paper contains five questions.
Question ONE is Compulsory and carries 30 Marks.
Attempt any TWO of the remaining four questions carrying 20 marks each.

Given Data : For free space assume the following data

Permitivity : $\varepsilon_0 = \frac{1}{36\pi}10^{-9}$ Farad/m
Permeability : $\mu_o = 4\pi \times 10^{-7}$ Henry/m
Speed of electromagnetic wave : $v_0 = 3 \times 10^8\ m/sec$

QUESTION ONE 30 MARKS (COMPULSORY)

a) State Maxwell's equations for time-varying fields and explain the physical significance of each equation in

i. Differential form and **(4 marks)**

ii. Integral form **(4 marks)**

iii. State the constitutive parameters that relate to the four Maxwell's equations

(2 marks)

b)

i. Define the word 'uniform plane wave' in free space **(2 marks)**

ii. Differentiate between the terms 'conduction' and 'displacement' current densities. **(2 marks)**

iii. Prove that for harmonic variation of E field, displacement current density= $j\omega\varepsilon\mathbf{E}$. **(2 marks)**

iv. State units of each symbol in the formula in (iii) above. **(2 marks)**

v. Show that the displacement current in the dielectric of a parallel plate capacitor is equal to the conduction current in its leads. **(2 marks)**

c)

i. A plane radio wave in the air is incident normally on a dielectric boundary. **(3 marks)**

ii. Derive formulae for reflection and transmission coefficients for both fields. **(3 marks)**

iii. Given that the electric field in the air is 1V/m and $\mu_r = 1$ & $\varepsilon_r = 3$ for other mediums, Find values of reflected and transmitted **E** and **H** fields. **(4 marks)**

QUESTION TWO (20 MARKS)

a) Energy transfer by electromagnetic waves as given by the mathematical equation by Poynting is :

$$\iiint \sigma E^2 dv + \frac{\delta}{\delta t}\iiint \left(\frac{\varepsilon E^2}{2} + \frac{\mu H^2}{2}\right) dv + \iint \left(E \times H\right) \bullet ds$$

i. Explain the physical significance of each term in this equation. **(3 marks)**

ii. Give a word statement of Poynting's theorem. **(2 marks)**

iii. Identify Poynting's vector and state its units. **(2 marks)**

iv. Explain how Poynting's vector is useful in specifying an electromagnetic wave's propagation direction. **(3 marks)**

b) Starting from Maxwell's two curl equations for free space obtain a three-dimensional wave equation in either E OR H. Assume harmonic variation of fields. **(3 marks)**

c) Assuming the general value of γ the propagation constant of electromagnetic waves in (b) above

i. Obtain formulae for α and β. **(2 marks)**

ii. State units of α and β. **(1 marks)**

d)

i. Obtain the value of impedance offered by free space to the electromagnetic waves. **(2 marks)**

ii. A plane uniform electromagnetic wave with a peak value of electric field intensity of 25 V/m is traveling in free space. Find average power crossing a circular area of radius 2 meters normal to the direction of travel. **(2 marks)**

QUESTION THREE (20 MARKS)

a) Assuming the value of γ, the propagation constant, Prove the following approximations for wave propagation in good conductors.

i. The magnitude of attenuation and phase constants are equal. **(2 marks)**

ii. Velocity is given by the formula: $v^2=2\omega/\mu\sigma$ and **(2 marks)**

iii. $\eta=j\omega\mu/\gamma$ for any medium **(2 marks)**

b) Electric field vector in free space of a plane uniform wave is given as $E_x = 12Sin(\omega t - \beta Z)$ V/m. The other two components are zero,

i) Show that the electromagnetic wave travels in positive 'z' direction. **(2 marks)**

ii) Using Maxwell's curl equation obtain the value of the associated 'H' field. **(2 marks)**

iii) Hence show that $E/H = \sqrt{\mu/\epsilon}$. **(3 marks)**

c) Define the following terms for a good conductor

i) Surface impedance and **(1.5 marks)**

ii) Skin depth **(1.5 marks)**

d) Determine the depth of penetration and the surface resistance for copper at 5 MHz. Given that the conductivity of copper is 58 MS/m and its relative Permeability as unity. **(4marks)**

QUESTION FOUR (20 MARKS)

a)

i. State and justify modification of Amper's law [Curl of H=J] as postulated by Maxwell for time-varying field. **(4 marks)**

ii. Using point forms of Faraday's and Amper"s laws along with Stoke's theorem, derive four Maxwell's equations. **(4 marks)**

iii. Obtain boundary condition for H field having surface current K A/m at the boundary of two dielectrics. **(4 marks)**

b) A TEM electromagnetic wave of E= 0.1 V/m peak, propagates through a lossless medium having relative values of μ=1 and ε=78 at f= 300MHz. Obtain the values of

i. β, λ, η and υ of the wave in the given medium. Symbols carry the usual meaning. **(4 marks)**

ii. Express E and H fields in sinusoidal form. **(4 marks)**

QUESTION FIVE (20 MARKS)

a) A y-polarized TEM wave travels in a z-direction in a lossless medium. It is incident obliquely making an angle 0 with the normal of a perfect infinite conductor plane surface placed at x=0.

i. Show that the wave satisfies Snell's law of reflection in optics. **(6 marks)**

ii. Obtain values of total E and H fields in the given medium. **(6 marks)**

b) Obtain an expression for the complex Poynting vector. **(3 marks)**

c) Show that

i. There exists a traveling wave in z-direction and a standing wave in x-direction. **(2 marks)**

ii. E field is zero at the conducting surface and also at all other planes parallel to it at a distance equal to X= $-m\lambda/2\text{Cos}0$ where m = 1,2 3. **(2 marks)**

iii. State the significance of this phenomenon, **(1 mark)**

DEDAN KIMATHI UNIVERSITY OF TECHNOLOGY

UNIVERSITY EXAMINATION 2024/2025

BACHELOR OF SCIENCE IN MECHANICAL, MECHATRONIC, ELECTRICAL & ELECTRONIC ENGINEERING, GEGIS, GIS, BACHELOR OF EDUCATION IN MECHANICAL, ELECTRICAL & ELECTRONIC ENGINEERING

THIRD/FOURTH YEAR ORDINARY EXAMINATION

SMA 3261 NUMERICAL METHODS

DATE: 17th January 2025 **Time: 11.00am**

Instructions: Answer Question ONE and any other TWO Questions

QUESTION ONE (30 Marks)

a) Find $y(0.12)$ using Newton forward difference formula and the data in the following table. (Correct to 5 decimal places) (5 Marks)

x	0.10	0.15	0.20	0.25	0.30
y	0.1003	0.1511	0.2027	0.2533	0.3093

b) Using trapezoidal rule evaluate $\int_1^5 \int_{1.4}^{2.2} \frac{dydx}{\sqrt{x^2+y^2}}$ with $\Delta x = 2$ and $\Delta y = 0.2$. Work with three decimal places. (5 Marks)

c) Find a real root of the equation $x \sin x + \cos x = 0$ in the interval $(9,10)$ using three iterations of Newton-Raphson method. Work with 5 decimal places. (5 Marks)

d) Using an appropriate Newton's method to find the value of $f'(4.5)$ from the following table. (5 Marks)

x	2.5	3.0	3.5	4.0	4.5
f	24.145	22.043	20.225	18.644	17.262

e) Use Fourth-order Taylor series method to solve the IVP $\frac{dy}{dx} = 3x + y^2, y(0) = 1$ at $x = 0.2$. (5 Marks)

f) Use Stirling's formula to find $f(6.4)$ from the values tabulated below. (5 Marks)

x	4	5	6	7	8
y	15.79	19.47	23.73	28.60	34.11

QUESTION TWO (20 Marks)

a) Determine a polynomial $f(x)$ that passes the points $f(-1) = 3, f(0) = -6, f(3) = 39$ using Lagrange interpolation. (5 Marks)

b) Use Newton's divided difference formula to find the polynomial $f(x)$ if $f(0) = 4, f(2) = 26, f(3) = 58, f(4) = 112, f(7) = 466$ and $f(9) = 922$. (5 Marks)

c) Given that $\frac{dy}{dx} = x^2 - y, y(0) = 1, y(0.1) = 0.9052, y(0.2) = 0.8213$ and $y(0.3) = 0.7492$, find $y(0.4)$ by Milne's predictor-corrector method, correct to 3 decimal places. (10 Marks)

QUESTION THREE (20 Marks)

a) Use Newton-Raphson method to derive a formula for computing the n^{th} root of a number hence use the derived formula to compute $\sqrt[5]{530}$ using one iteration. (4 Marks)

b) Use Romberg integration method to compute $\int_0^1 f(x)dx$ using $h = 0.5, 0.25, 0.125$ using the data in the table below. Work with four decimal places. (5 Marks)

x	0	0.125	0.25	0.375	0.5	0.625	0.75	0.875	1.0
$f(x)$	1	0.9846	0.9412	0.8767	0.8000	0.7191	0.6400	0.5664	0.5

c) Estimate the value of $f'(32)$ from the following data using and appropriate Newton's method. (5 Marks)

x	10	15	20	25	30	35
$f(x)$	19.97	21.51	22.47	23.52	24.65	25.89

d) Compute $y(0.1)$ by Runge-Kutta method of 4^{th} order for the initial value problem $\frac{dy}{dx} = 2e^x - y, y(0) = 2$. Work with 5 decimal places. (6 Marks)

QUESTION FOUR (20 Marks)

a) Evaluate $\int_4^{5.2} \log x \, dx$ by Simpson's one-third rule with 6 subintervals. Work with four decimal places. (5 Marks)

b) Use Inverse Langrage interpolation to determine the value of x that corresponds to $f(x) = 2.0$ for the following data. (5 Marks)

x	1	2	3	4
$f(x)$	3.6	1.8	1.2	0.9

c) Using two iterations Modified Euler's method, find an approximate value of $y(1.1)$ and $y(1.2)$ given that $\frac{dy}{dx} = x^2y + x^2, y(1) = 1$. (10 Marks)

QUESTION FIVE (20 Marks)

a) Use Stirling's formula to find $f'(1.22)$ from the data given in the table below. (5 Marks)

x	1.0	1.1	1.2	1.3	1.4
$f(x)$	0.8415	1.8912	0.9320	0.9636	0.9855

b) Using Lagrange's formula express the function $\frac{x^2+x-3}{(x+1)(x-1)(x-4)}$ as a sum of its partial fractions. (5 Marks)

c) Apply Adam-Bashforth-Moulton predictor-corrector method, find y at $t = 4.4$ from the differential equation $\frac{dy}{dt} = \frac{1}{5t}(2 - y^2)$ given that $y(4) = 1, y(4.1) = 1.0049, y(4.2) = 1.0097, y(4.3) = 1.0143$. Work with 5 decimal places. (10 Marks)

DEDAN KIMATHI UNIVERSITY OF TECHNOLOGY

University Examinations 2024/2025 Academic Year

THIRD YEAR SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING, BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING, BACHELOR OF SCIENCE IN TELECOMMUNICATION AND INFORMATION ENGINEERING AND BACHELOR OF EDUCATION IN ELECTRICAL AND ELECTRONIC ENGINEERING

SAS 2130: Statistics

DATE: 13th January 2025 TIME: 11:00 am. - 01:00 pm.

Instructions to Candidates:

1). Answer **QUESTION ONE** and any other **TWO QUESTIONS.**

2). **Mobile Phones** are **NOT** allowed in the examination room.

3). You are **NOT** allowed to write on this examination question paper.

QUESTION ONE (30 Marks) (COMPULSORY)

a). The following data represents monthly average allowance (in KSH 000's) of 50 engineering interns sampled from DeKUT.

75, 89, 94, 190, 74, 50, 52, 122, 112, 95, 100, 78, 65, 60, 90, 83, 87, 75, 114, 85, 69, 94, 124, 115, 107, 88, 97, 125, 74, 72, 68, 57, 54, 52, 35, 51, 56, 61, 68, 56, 55, 54, 83, 91, 90, 102, 77, 125, 108, 65

i). Construct a stem and leaf plot of the data. [2 Marks]

ii). Determine the quartiles and check if there are outliers in the data. [6 Marks]

iii). Draw a box plot and comment on the skewness of the data. [3 Marks]

iv). Compute the 20% trimmed mean for the above data set. [3 Marks]

c). Two samples 1 and 2 of CAT scores are taken from students in a Statistics class. The samples are of sizes 60 and 85 respectively, have equal mean but different variances. The variance of sample 1 is 625 while that of sample 2 is 81. Find the standard deviation of the combined group. **[3 Marks]**

d). The grades of a Mechanical engineering class of 12 students in a mid of semester exam (x) and end of semester exam (y) are given in as follows;

X	81	67	71	72	77	60	94	80	50	99	96	78
Y	47	68	78	30	34	82	39	60	40	85	92	99

i). Compute coefficient of correlation and comment. **[3 Marks]**

ii). Fit the linear regression line and hence estimate the end of semester examination grade of a student who received a grade of 85 on the mid of semester exam. **[3 Marks]**

e). In an examination of nine applicants for a clerical post, the marks obtained in mathematics and statistics paper were as follows;

Maths Score	15	28	28	12	40	60	20	80	28
Statistics Score	40	30	39	30	20	11	30	60	40

Compute the rank correlation coefficient to investigate whether there is a relationship between the rank of scores in the two subjects. **[3 Marks]**

f). A shop keeper buys a particular kind of light bulbs from three manufacturers. A,B and C she buys 30% of her stock from A, 45% from B and 25% from C. In the past, she has found that 2% of C's bulbs are faulty whereas only 1% of A's and B's are. Suppose that she chooses a bulb at random and it is faulty, what is the probability that it was one of C's bulbs. **[4 Marks]**

QUESTION TWO (20 Marks) (Optional)

a). The table below shows the marks obtained by 100 students in a statistics exam.

Marks	0-10 1 - 10	10 - 20	20 - 30	30 - 40	40 - 50	50 - 60
No. of Students	x	8	12	22	48	y

The average mark for the class in the examination was ~~48.5~~ 35.5
Determine:

i). The values of x and y. **[4 Marks]**

ii). The score of the middle 50 % of the students. **[3 Marks]**

iii). The mark obtained by the highest number of students. **[2 Marks]**

iv). The standard deviation of the marks using the coding method. **[4 Marks]**

b). For a certain data set of size 20, $\sum x = 154$ and $\sum x^2 = 2,045$. Determine the mean and the standard deviation of the data set after dropping a value of 19 from the data set. **[3 Marks]**

c). For a group of 100 candidates the mean and standard deviation of their marks were found to be 60 and 15 respectively. Later on it was found that the scores 45 and 72 were wrongly entered as 40 and 27. Find the correct mean and standard deviation. **[4 Marks]**

QUESTION THREE (20 Marks) (Optional)

a). In a certain type of metal test specimen, the normal stress on a specimen is known to be functionally related to the shear resistance. The following is a set of coded experimental data on the two variables:

Normal Stress, x	Shear Resistance, y
26.8	26.5
25.4	27.3
28.9	24.2
23.6	27.1
27.7	23.6
23.9	25.9
24.7	26.3
28.1	22.5
26.9	21.7
27.4	21.4
22.6	25.8
25.6	24.9

i). Find the Pearson's moment correlation coefficient and interpret it. **[4 Marks]**

ii). Calculate the coefficient of determination and explain its meaning. **[2 Marks]**

ii). Find the regression line and use it to estimate the shear resistance for a normal stress of 24.5. **[5 Marks]**

b). A multiple choice exam has 4 choices for each question. The student has studied enough so that the probability they know the answer to a question is 0.5, the probability that the student will be able to eliminate one choice is 0.25, otherwise all 4 choices seem equally plausible. If they know the answer they will get the question correct. If not they have to guess from the 3 or 4 choices. As the teacher, you would like the test to measure that student knows, and not how well they can guess. If the student answers a question correctly, what is the probability that they actually know the answer?

[5 Marks]

c). Three engineers A, B, and C have applied for a job in a private company. The chance of their selection is in the ratio $1 : 2 : 4$. The probabilities that A, B, and C can introduce changes to improve the profits of the company are 0.8, 0.5 and 0.3 respectively. If the change does not take take place, find the probability that it is due to the appointment of engineer C. **[4 Marks]**

QUESTION FOUR (20 Marks) (Optional)

a). The consumption of number of Tea and Coffee on a particular week by a family are given below.

Tea	3	5	6	4	3	5	4
Coffee	1	3	7	9	2	6	2

Which beverage is consistently consumed by the family? **[5 Marks]**

b). Three machines A, B and C produces 50%, 30% and 20% of items in a factory. The % defective items from each of the machines are 3%, 4% and 5% respectively. If an item is chosen at random and is found to be defective, what is the probability that it was produced by machine B? **[4 Marks]**

c). A student is likely to wake up on time with probability $3/4$. If he wakes up on time, there is a probability of $9/10$ that he will arrive in the dining hall in time for breakfast. If he oversleeps, there is a probability of $1/2$ that he will arrive at the dining hall in time for breakfast. If he is late in arriving at the dining hall there is a probability of $2/3$ that he will miss breakfast, but on occasion he arrives at the dining hall on time he has breakfast. What is the probability that on any day he will miss breakfast?

[3 Marks]

d). In a batch of manufactured items, 5% of the items have a fault. A diagnostic test has 90% chance of detecting an item that is faulty, but also 1% chance of giving a false position when an item really has no fault. Compute the probability that an item which has been diagnosed as being faulty, is, in fact, faulty. **[4 Marks]**

e). Given two events A and B such that $P(A|B) = 0.8$, $P(A) = 0.5$, and $P(B) = 0.25$. Determine

i). $P(A \cap B)$. **[2 Marks]**

ii). $P(B|A)$. **[2 Marks]**

QUESTION FIVE (20 Marks) (Optional)

a). The random variable X has the following probability distribution:

$$P(X = x) = kx, \quad x = 1, 2, 3, 4, 5$$
$$P(X = x) = k(10 - x), x = 6, 7, 8, 9$$

Find;

i). the value of constant k **[2 Marks]**

ii). $E(3X)$ **[3 Marks]**

iii). $Var(2X - 3)$ **[3 Marks]**

b). A random variable X has the following probability mass function,

X	-2	-1	0	1	2	3
$P(X = x)$	0.1	k	0.2	$2k$	0.3	k

Find

i). the value of k, [2 Marks]

ii). the mean and variance of X. [5 Marks]

c). Determine the first four moments about the point $A = 25$ of the following distribution. Hence investigate the skewness and peakedness of the distribution.

Class	0 - 10	11 - 20	21 - 30	31 - 40	41 - 50	51 - 60
Frequency	10	25	40	10	5	2

[5 Marks]

DEDAN KIMATHI UNIVERSITY OF TECHNOLOGY

UNIVERSITY EXAMINATIONS 2024/2025

THIRD YEAR SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF EDUCATION IN TECHNOLOGY (ELECTRICAL & ELECTRONIC ENGINEERING),

BACHELOR OF SCIENCE IN ELECTRICAL & ELECTRONIC ENGINEERING,

AND

BACHELOR OF SCIENCE IN TELECOMMUNICATION & INFORMATION ENGINEERING

EEE/ETI 3209 ANALOGUE ELECTRONICS II

DATE: 16/01/2025 TIME: 2-4PM

INSTRUCTIONS:

Answer QUESTION ONE (COMPULSORY) and ANY other TWO questions.

QUESTION ONE [COMPULSORY – 30 MARKS]

a) Distinguish between *positive feedback* and *negative feedback* in an amplifier. Use neat diagrams showing the input signal, feedback signal and output signal waveforms. **[4 Marks]**

b) State FOUR advantages of *negative feedback* in an amplifier. **[4 Marks]**

c) What is the difference between a *differential amplifier* and a *conventional amplifier*? **[2 Marks]**

d) The gain and distortion of an amplifier are 150 and 5% respectively without feedback. If the stage has 10% of its output voltage applied as negative feedback, find the distortion of the amplifier with feedback.
[3 Marks]

e) Distinguish between *small signal amplifiers* and *large signal amplifiers*. Give an example of each.
[4 Marks]

f) Enumerate THREE features which should be incorporated in *power amplifiers* in order to achieve high *power* amplification.
[3 Marks]

g) In a certain transistor amplifier, $i_{c(max)} = 220$ mA, $i_{c(min)} = 30$ mA, $V_{ce(max)} = 15$ V and $V_{ce(min)} = 3$ V. Calculate the ac output power. **[3 Marks]**

h) Define the following terms as used for *differential amplifiers*:
   i. Common mode rejection ratio (CMRR) **[1 Mark]**
   ii. Output offset voltage **[1 Mark]**
   iii. Input offset current **[1 Mark]**

iv. Input bias current [1 **Mark]**

i) A *differential amplifier* has an output of 2V with a differential input of 12 mV and an output of 4 mV with a common-mode input of 9 mV. Find the CMRR in dB. **[3 Marks]**

QUESTION TWO [20 MARKS]

a) With the aid of a well labeled diagram of a *current-shunt feedback* circuit, explain the principle of negative current feedback. **[6 Marks]**

b) Fig Q2(b) shows an amplifier circuit. Assume the transistor to be made of silicon. Given that the input voltage results in a peak base current of 15 mA and Vcc=15V, determine;

i. Base current, I_B **[2 Marks]**

ii. Collector current, I_C **[2 Marks]**

iii. Output voltage, V_{CE} **[2 Marks]**

iv. Output power, $P_{0(ac)}$ **[4 Marks]**

v. Input power, $P_{(dc)}$ **[2 Marks]**

vi. Collector efficiency, η **[2 Marks]**

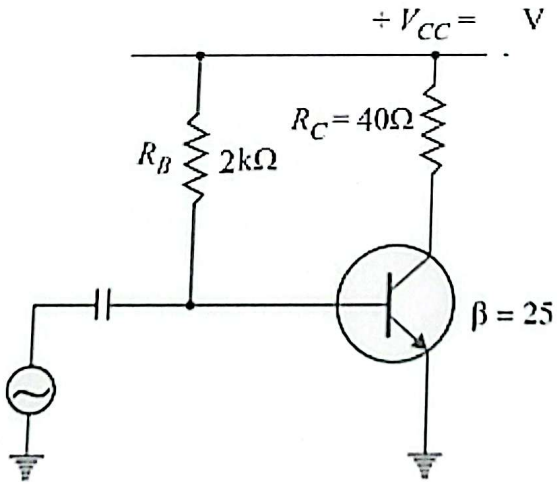

Fig. Q2(b)

QUESTION THREE [20 MARKS]

a) Discuss the operation of a *single-ended input, double-ended output* differential amplifier **[10 Marks]**

) A *Class A* power amplifier has a transformer as the load, and the zero signal collector current is 100 mA. If the transformer has a turn ratio of 20 and the secondary load is 250 Ω, find the maximum a.c. power output. **[4 Marks]**

Derive the expression for the *collector efficiency* of a power amplifier. **[6 Marks]**

QUESTION FOUR [20 MARKS]

a) Discuss **THREE** classifications of power amplifiers.
[6 Marks]

b) Using a well-labeled sketch of a *negative voltage feedback amplifier*, derive an expression for the gain with feedback (A_{vf}).
[6 Marks]

c) For the differential amplifier circuit shown in Fig. Q4(c), determine the bias voltages and currents;

i. I_{E1} and I_{E2} **[3 Marks]**

ii. I_{C1} and I_{C2} **[2 Marks]**

iii. V_{C1} and V_{C2} **[3 Marks]**

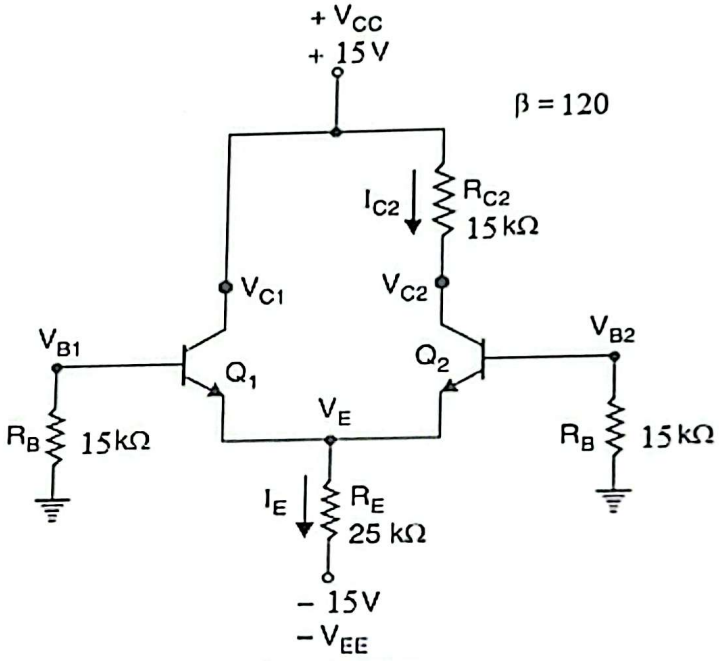

Fig. Q4(c)

QUESTION FIVE [20 MARKS]

a) Discuss **THREE** *performance quantities* of power amplifiers. **[6 Marks]**

b) A *Class A* transformer-coupled power amplifier has zero signal collector current of 60 mA. If the collector supply voltage is 4 V, find;

i. The maximum a.c. power output **[2 Marks]**

ii. The power rating of the transistor **[3 Marks]**

iii. The maximum collector efficiency. **[2 Marks]**

c) Using a neat sketch of a *negative current feedback* circuit, show that negative current feedback *decreases* the output impedance of an amplifier. **[7 Marks]**

DEDAN KIMATHI UNIVERSITY OF TECHNOLOGY

UNIVERSITY EXAMINATION 2024/2025

THIRD YEAR SECOND SEMESTER EXAMINATION FOR THE DEGREE OF

BACHELOR OF SCIENCE IN ELECTRICAL & ELECTRONIC ENGINEERING

BACHELOR OF SCIENCE IN TELECOMMUNICATION & INFORMATION ENGINEERING

BACHELOR OF EDUCATION IN TECHNOLOGY (ELECTRICAL & ELECTRONIC ENGINEERING)

EEE, ETI 3206: DIGITAL ELECTRONICS II

14/01/2025 2-4PM

DATE: DECEMBER 2024 TIME 2HRS

INSTRUCTIONS: This examination paper contains five questions. Answer Question One and any other Two questions. Question One is compulsory and carries 30 Marks and all the other questions carry 20 Marks each.

Question 1:

a. Define the following terms as used in Digital Electronics

i). HDL (1 Mark)

ii). Abstraction (1 Mark)

iii). Instantiation (1 Mark)

b. Differentiate between the following terms as used in semiconductor memories

(i) Static memories and Dynamic memories (2 Marks)

(ii) Random access and Sequential access **(2 Marks)**

(iii) Fan-in and Fan-out **(2 Marks)**

(iv) Latch and Flip Flop **(2 Marks)**

c. The following memory units are specified by the number of words times the number of bits per word. How many address lines and I/O data lines are needed in each case?

(i) $2k \times 16$ **(1 Mark)**

(ii) $64k \times 8$ **(1 Mark)**

(iii) $16M \times 32$ **(1 Mark)**

(iv) $96k \times 12$ **(1 Mark)**

d. Consider the schematic in Figure Q1c. Determine:

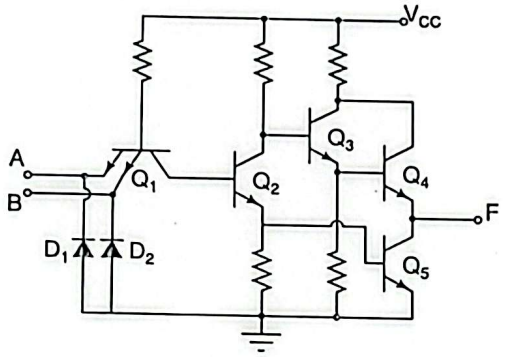

Figure 1: Q1c

(i) Identify the logic family **(1 Mark)**

(ii) Identify the logic gate represented. **(1 Mark)**

(iii) Predict how the operation will be affected as a result of the following faults:

- either D_1 or D_2 fails shorted, **(1 Mark)**
- either D_1 or D_2 fails open, **(1 Mark)**
- R_1, R_2 or R_3 fails open. **(1 Mark)**

e. For the following Boolean expression, realize the CMOS implementation

$$F = \overline{ABC + (A + B + C)D}$$

(5 Marks)

f. Calculate the fan out of a TTL circuit wit the following specifications in Table Q1f: (5

Table 1: Q1f

$I_{OL(max)}$	$I_{IL(max)}$	$I_{OH(max)}$	$I_{IH(max)}$
32mA	1.6mA	400μA	10μA

Marks)

Question 2:

a. What is the main advantage and disadvantage of Static RAM over Dynamic RAM?Explain your answers. (4 Marks)

b. A comparator used to compare two binary numbers each of two bits is called a 2-bit Magnitude comparator. It consists of four inputs and four outputs to generate less than(LT), not equal to(NE), equal to (ET), and greater than(GT) between two binary numbers.

(i) generate the four Kanaugh maps (2 Marks)

(ii) deduce the expressions for the four outpits (4 Marks)

(iii) show the implementation using a PLA (4 Marks)

c. Write a verilog code and the associated testbench to implement the comparator in Q2b. (6 Marks)

Question 3:

a. Define the following terms as used in FSM

i). State (1 Mark)

ii). Transition (1 Mark)

iii). Redundant states (1 Mark)

iv). State Machine (1 Mark)

b. For the FSM shown in Figure Q3b shown below

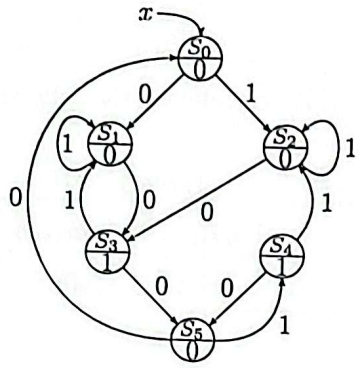

Figure 2: Q3b

i). Using the implication table or otherwise, remove the redundant states **(3 Marks)**

ii). Draw the simplified state diagram **(3 Marks)**

iii). Draw the state table and Implement the machine using JK Flip Flops **(4 Marks)**

c. For the sequential circuit shown in Figure Q3c; draw the associated state transition diagram

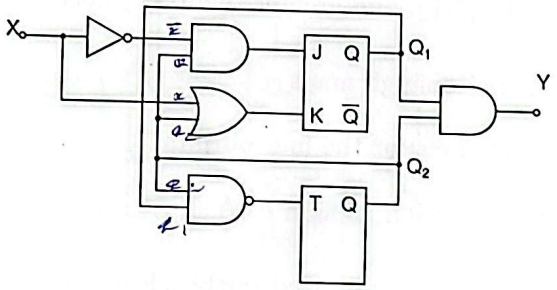

Figure 3: Q3c

for

i). Moore machine **(3 Marks)**

ii). Mealy machine **(3 Marks)**

Question 4:

a. Define the following terms as used in semiconductor memories

(i) Static memories **(1 Mark)**

(ii) Dynamic memories **(1 Mark)**

(iii) Random access (1 Mark)

(iv) Sequential access (1 Mark)

b. An IC RAM chip has a capacity of $1k \times 8$

i). How many address and data lines are there in the chip? (2 Marks)

ii). How many chips are needed to construct a $16k \times 16$ RAM? (2 Marks)

iii). How many address and data lines are there in the $16k \times 16$ RAM? (2 Marks)

iv). What size decoder is needed to construct the $16k \times 16$ memory from the $1k \times 8$ chips? What are the inputs to the decoder and where are its outputs connected? (2 Marks)

c. The semiconductor random access memory of a computer has 65,536 words, each of 8-bits. It can perform two basic operations of Read and Write.

(i) How many address lines are there? (1 Mark)

(ii) How many data lines are there assuming same pins are used for data in and out? (1 Mark)

(iii) ignoring the power pins, draw the memory package. (1 Mark)

(iv) Realize a memory of a capacity of 147,456 words using the packages above. (1 Mark)

(v) Draw the timing diagram of the Read operation (2 Marks)

(vi) Draw the timing diagram of the Write optation. (2 Marks)

Question 5:

a. Define Hardware Descriptive Languages(HDLs) and justify the need for them. (4 Marks)

b. For the following boolean function

$$F(A,B,C,D) = \sum m(0,2,8,9,10,15) + \sum d(3,4,5,11)$$

i). Use Kanaugh map to write the minimized sum-of-products for F (2 Marks)

ii). Write a behavioral and dataflow verilog codes. (4 Marks)

iii). Write the associated verilog testbench. (4 Marks)

c. Write a verilog code and the associated testbench to implement the FSM in Figure Q3b. (6 Marks)

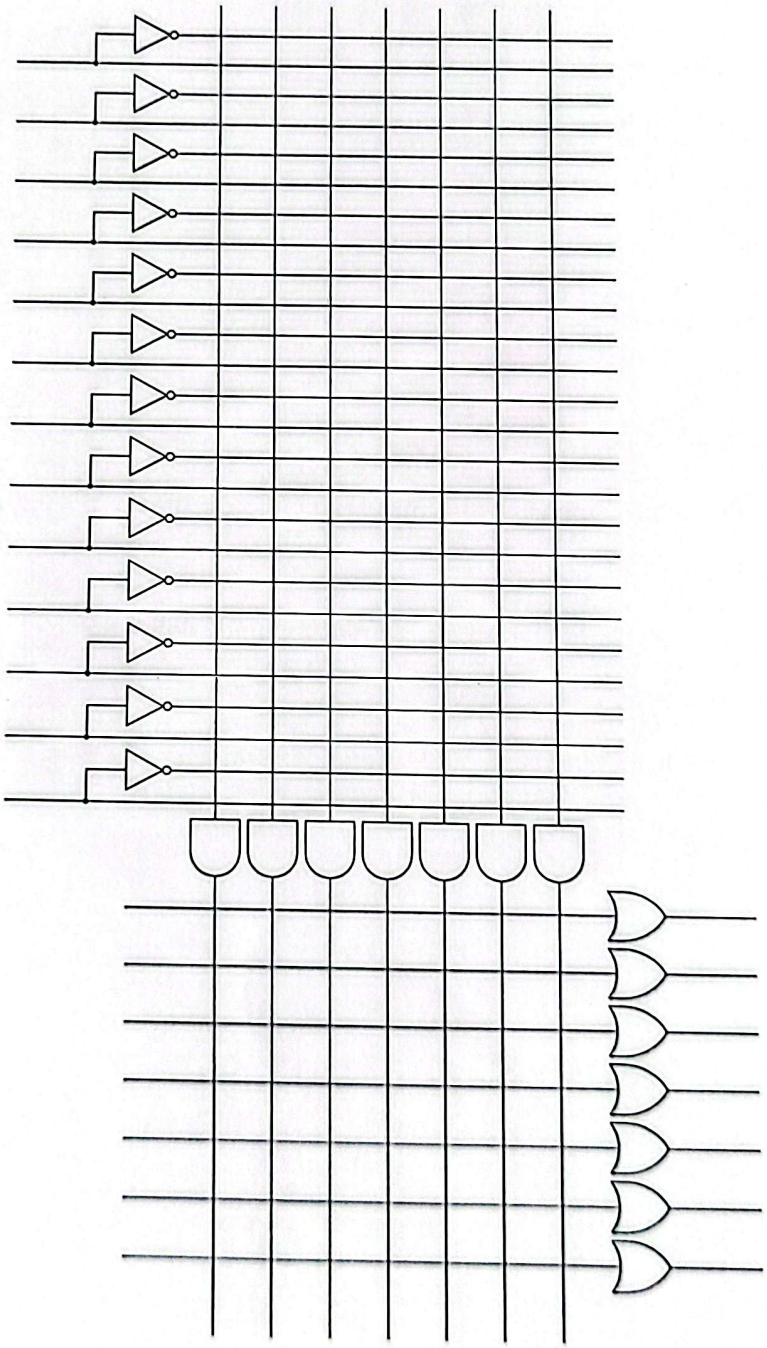

Figure 4: PLA template