PAPER ONE

TECHNICAL UNIVERSITY OF MOMBASA

School of Engineering and Technology

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

UNIVERSITY EXAMINATION FOR:

BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING

EEE 4311 ELECTROMAGNETICS II

END OF SEMESTER EXAMINATION

SERIES: APRIL 2023

TIME: 2 HOURS

DATE: April 2023

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of **FIVE** questions. Attempt **Question ONE and ANY other TWO questions.**

Do not write on the question paper.

Question ONE

(a) State mathematically and explain the practical significance of ALL Maxwell's equations in integral form (8 marks)

(b) In free space $\bar{E} = E_m cos(\omega t - 50x)\hat{a}_y$ v/m. Determine

(i) Displacement current I_d (ii) Angular frequency ω (iii) Magnetic field intensity, $\bar{H}$ (10 marks)

(c) Suppose that a uniform plane is travelling in the x −direction in a lossless dielectric ($\mu_r = 1$) with $100V/m$ electric field component in the − z direction. If the wavelength is $0.25m$ and the velocity of propagation is $2 \times 10^8 m/s$. Draw the phasor diagram of the electric and magnetic field vectors and determine the:

(i) Relative permittivity of the medium (ii) Frequency of the wave

(iii) Complete time domain expressions for the electric and magnetic field expressions

(iv) Average power density (12 marks)

Question TWO

(a) Given $D = D_m \sin(\omega t + \beta z)\, \hat{a}_x$ and using Faraday's law show that $B = -\frac{\omega \mu_0 D_m}{\beta} \sin(\omega t + \beta z) \hat{a}_y$

(12 marks)

(b) Consider the circuit of Fig. Qu.2(b) and using appropriate sketches highlight the problem of lead inductance of the connecting wire at $50Hz$ and $5GHz$ respectively. (8 marks)

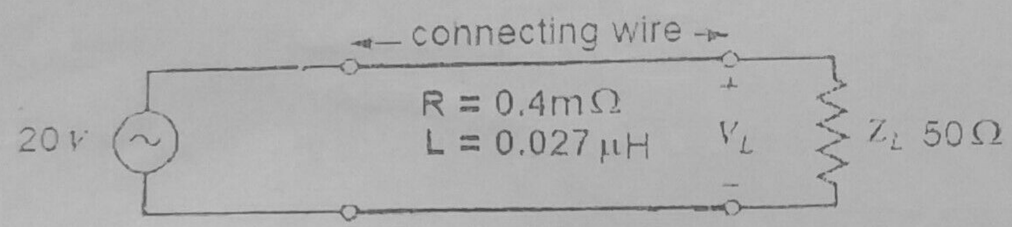


Fig.Qu.2(b)

Question THREE

(a) State mathematically and explain the practical significance of the curl of a vector. (4 marks)

(b) Determine the voltage V in the circuit of Fig.Qu.3(b). Show all your workings clearly, motivating steps taken and indicating Faraday's sources. (16 marks)

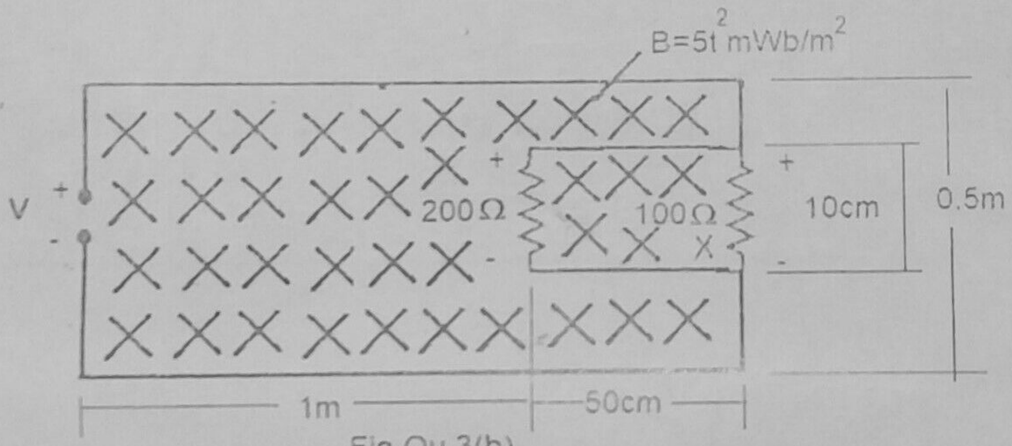


Fig.Qu.3(b)

Question FOUR

Given the Maxwell equations: $\nabla X \hat{E} = -j\bar{w}\mu\hat{H}$; $\nabla X \hat{H} = \hat{J} + \hat{J}\omega\varepsilon_0\hat{E}$

Prove that $\hat{E}_x = E_m{}^{+} e^{-j\beta z} + E_m{}^{-} e^{j\beta z}$; $\hat{H}_y = \frac{E_m{}^{+}}{\eta} e^{-j\beta z} + \frac{E_m{}^{-}}{\eta} e^{j\beta z}$;

Explain all your steps and assumptions clearly. (20 marks)

Question FIVE

(a) With reference to Fig. Qu. 5(a), medium 1 is air and medium 2 is Epoxy resin ($\mu_{r2} = 1, \varepsilon_{r2} = 3.6$). Assume the Epoxy resin is infinitely thick so that no reflected waves exist in the epoxy resin. Write the time expressions for all the fields in these two media if the transmitted electric field in medium 2 is measured as $E^t = 10\cos\left(wt - \left(\frac{8\pi}{3}\right)z\right)\hat{a}_x$

(13 marks)

(b) Determine the average incident, reflected and transmitted power density of the plane wave and show that energy is conserved across the interface.

(7 marks)

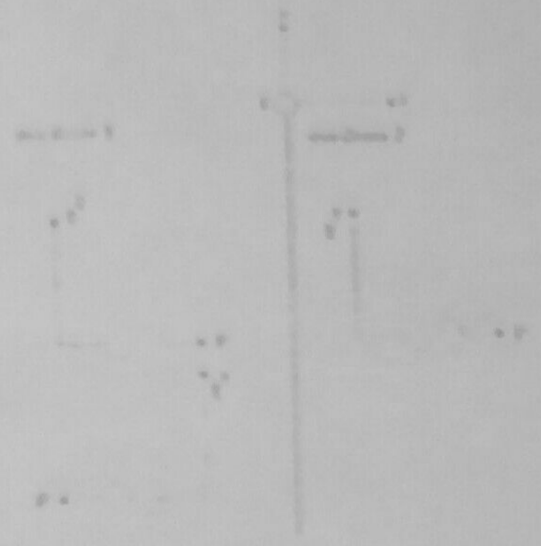


Fig. Qu. 5(a)

TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF APPLIED AND HEALTH SCIENCES

DEPARTMENT OF MATHEMATICS & PHYSICS

UNIVERSITY EXAMINATION FOR:

ELECTRICAL AND ELECTRONIC ENGINEERING

AMA 4302: PDE

END OF SEMESTER EXAMINATION

SERIES: APRIL 2023

TIME: TWO HOURS

DATE: APRIL 2023

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of FIVE questions. Attempt QUESTION ONE AND ANY OTHER TWO QUESTIONS

Do not write on the question paper.

Question ONE (30 Marks)

a) Form the PDE by eliminating the arbitrary constant $z = ae^{pt}\sin(px)$ hence state the order of the resulting PDE formed (4mks)

b) Form the PDE by eliminating the arbitrary function from $\phi\left(x^2e^z, ye^z\right)=0$ (5mks)

c) Obtain the Laplace transforms of :

i. u_x (3mks)

ii. u_{xx} (3mks)

d) Find the integral curves of the equations $\frac{dx}{zy} = \frac{dy}{y^2} = \frac{dz}{zxy-2x^2}$ (7mks)

e) Find the Fourier transform of $f(x)=e^{-a|x|}$ where $a>0$ (8mks)

Question TWO **(20 Marks)**

a) Given the relation $u = f(xy)$, obtain a partial differential equation by eliminating the arbitrary functions (3mks)

b) Find the integral curves of the equations $\frac{dx}{y(x+y)+bz} = \frac{dy}{x(x+y)-bz} = \frac{dz}{z(x+y)}$ (6mks)

c) Find the general solution of the langrage equation $x^2\frac{\partial z}{\partial x} + y^2\frac{\partial z}{\partial y} = (x+y)z$ (5mks)

d) Solve the following equation $4\frac{\partial u}{\partial x} + \frac{\partial u}{\partial y} = 3u, u(0,y) = e^{-5y}$ by the method of separation of variables (6mks)

$(x-y)^2 - (x+y)$

x^2

Question THREE **(20 Marks)**

a) Given the general solution $F(u,v) = 0$, where $u = u(x,y,z), v = v(x,y,z)$ by eliminating the arbitrary functions show that $Pp + Qq = R$ where P, Q, R, p, q have their usual meaning. (9mks)

b) Explain the circumstances at which the derived PDE in (a) above could be classified as linear, Semi linear or Quasi-linear (3mks)

c) Use the method of characteristics to solve $2u_x - u_y = 0, u(x,0) = f(x)$ (8mks)

$x - xy \quad x \quad x-y$

Question FOUR **(20 Marks)**

a) Find the orthogonal trajectories on the sphere $x^2 + y^2 + z^2 = a^2$ of its intersections with the Paraboloids $xy = cz$, c being a parameter. (8mks)

b) Find the surface which is orthogonal to the one parameter system $z = cxy(x^2 + y^2)$ which passes through the hyperbola $x^2 - y^2 = a^2; z = 0$ (8mks)

c) Show that the direction cosines of the tangent at the point (x,y,z) to the conic $ax^2 + by^2 + cz^2 = 1, x + y + z = 1$ are proportional to $(by - cz, cz - ax, ax - by)$ (6mks)

$\frac{cdx}{c(x+y)+bz} \qquad (x+y)z$

$(x+y)(x-y)$

Question FIVE **(20 Marks)**

a) Solve the Langrages equation $p+3q=5z+\tan(y-3x)$ (8mks)

b) An infinitely long string having one end at $x=0$ is initially at rest on the $x-$axis. At $t=0$, the end $x=0$ begins to move along the $u-$axis in a manner described by $u(0,t)=a\cos\omega t$.

i. Model the problem and explicitly state the necessary boundary conditions and the initial conditions (4mks)

ii. Use Laplace transform to find the displacement $u(x,t)$ of the string at any point at any time. (8mks)

PP1

TECHNICAL UNIVERSITY OF MOMBASA

SCHOOL OF ENGINEERING & TECHNOLOGY

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

UNIVERSITY EXAMINATION FOR:

BACHELOR OF SCIENCE IN ELECTRICAL & ELECTRONIC ENGINEERING

EEE4316: PHYSICAL ELECTRONICS II

END OF SEMESTER EXAMINATION

SERIES: APRIL, 2023

TIME: 2 HOURS

DATE: APRIL, 2023

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of FIVE questions. Answer question ONE and any other two.

Do not write on the question paper.

Question ONE

(a) Consider field-effect transistors.

(i) Draw the circuit symbols of JFETs.

(ii) Describe how the symbols show the use of a p or an n-channel

(iii) Describe how the symbols show the use of an insulted gate

(iv) Describe how the symbols show whether or not a conducting paths exists between drain and source when the gate-source voltage is zero. (10 marks)

(b) (i) Draw the static common emitter output characteristics for a low-power silicon NPN BJT. Show all the operating regions

(ii) A given NPN transistor has $\beta = 100$. Determine the region of operation if:

(I) $I_B = 50\ \mu A$ and $I_C = 3\ mA$

(II) $I_B = 50\ \mu A$ and $V_{CE} = 5\ V$

(III) $V_{BE} = -2\ V$ and $V_{CE} = -1\ V$ (12.5 marks)

(c) (i) Classify optical devices

(ii) When $3x10^{11}$ photons each with a wavelength of 0.85 μm are incident on a photodiode, on average $1.2x\ 10^{11}$ electrons are collected at the terminals of the device. Determine:

(I) the quantum efficiency

$h = 6.63 \times 10^{-34}\ J\text{-}s$

$e = 1.6 \times 10^{-19} C$

(ii) the responsivity of the photodiode at 0.85 μm. (7.5marks)

Question TWO

(a) For a JFET show that $I_{Dsat} = I_{Dss}\left(1 - \frac{V_{GS}}{V_P}\right)^2$ (16.5 marks)

(b) Find the pinch-off voltageof a silicon p-channel FET with half-channel height of 2 microns and channel resistivity of 10 Ω-m. Dielectric onstant for silicon is 12, μ_p= 500 cm^2/Vs, ε_o=8.849x 10^{-12} F/m. (3.5 marks)

Question THREE

(a) Consider an optical detector.
(i) Describe its function
(ii) State THREE important performance and compatibility requirements for optical detector. (4 marks)

(b) A photodiode has a quantum efficiency of 65 % when photons of energy 1.5×10^{-19} J are incident upon it.
(i) Determine the photodiode operating wavelength
(ii) Calculate the incident optical power required to obtain a photo current of 2.5uA when a photodiode is operating as described above. (6 marks)

(c) Define the following terms as used in optical devices and state their units of measurement.
(i) Illumination intensity
(ii) Luminous flux
(iii) Illumination
(iv) Irradiance. (8 marks)

(d) State the major difference between LED and LASER(diode). (2 marks)

Question FOUR

(a) (i) Sketch the energy band diagram for NPN transistor at equilibrium and active mode bias.
(ii) Use this diagram to explain the operation of NPN transistor (13 marks)

(b) Calculate the emitter current in a transistor for which β=100 and I_B= 25 μA. (3 marks)

(c) Sketch the common- emitter representation of the Ebers-Moll model. (4 marks)

Question FIVE

(a) (i) Describe 'unipolar' transistors

(ii) Sketch the basic structure of V-MOST and explain its principle of operation

(iii) State FOUR advantages of V-MOST power FET over FETs. (11 marks)

(b) (i) Descrbe Early effect or basewidth modulation in transistors

(ii) Explain qualitatively the Two consequences of Early Effect in BJT operation.

(3 marks)

(c) Consider a solar cell

(i) Describe it

(ii) Draw its circuit symbol and current- voltage characteristics

(iii) Define the following terms as applied to solar cells:

(I) Power conversation efficiency

(II) Fill factor

(6 marks)

TECHNICAL UNIVERSITY OF MOMBASA

School of Engineering and Technology
Department of Electrical & Electronic Engineering
UNIVERSITY EXAMINATION FOR:
BSc-ELECTRICAL
EMC 4314 : Thermodynamics
END OF SEMESTER EXAMINATION
SERIES: APRIL 2023
TIME: 2 HOURS
DATE: Pick Date Apr 2023

Instruction to Candidates:

You should have the following for this examination

- *Student I.D. Card & Examination Pass*
- *Answer booklet*
- *Non-Programmable scientific calculator*
- *Steam tables and standard Mollier chart*

This paper consists of **FIVE** questions. Attempt question **ONE** and any other **TWO** questions.

Maximum marks for each part of a question are as shown.

Do not write on the question paper.

Question ONE

(a) (i) (I) Define REVERSIBILITY in thermodynamics cycles,

(II) List any THREE examples of IRREVERSIBILITY PROCESS

(ii) Unit mass of a certain fluid is contained in a cylinder at an initial pressure of 20 bar. The fluid is allowed to expand reversibly behind a piston according to a law $pV^2 = \text{constant}$ until the volume is doubled. The fluid is then cooled reversibly at constant pressure until the piston regains its original position; heat is then supplied reversibly with the piston firmly locked in position until the pressure rises to the original value of 20 bar. Calculate the net work done by the fluid, for an initial volume of 0.05 m^3.

(8 Marks)

(b) (i) With the aid of sketch described a simple experiment that may be used to verify the FIRST LAW of thermodynamics:

(ii) In a certain steam plant, the turbine develops 1000 kW. The heat supplied to the steam in the boiler is 2800 kJ/kg, the heat rejected by the steam to the cooling water in the condenser is 2100 kJ/kg and the feed-pump work required to pump the condensate back into the boiler is 5 kW. Calculate the steam flow rate.

(8 Marks)

(c) With the aid of a flow and T-s diagram briefly explain the various processes in steam plant working on Rankine cycle, writing down the cycle efficiency and specific steam consumption in terms of enthalpies.

(14 Marks)

Question TWO

(a) In a reversible process for perfect gas that obeys the law $pv^{\gamma} = constant$, where p is pressure, v is volume and γ – process index, derive the relationship between temperature, T and v, for initial state 1 and final state 2;

(9 Marks)

(b) 0.1 m^3 of an ideal gas at 300 K and 1 bar is compressed adiabatically to 8 bars. It is then cooled at constant volume and further expanded isothermally so as to reach the condition from where it started. Calculate:

(i) Pressure at the end of constant volume cooling.

(ii) Change in internal energy during constant volume process.

$C_p = 14.2\ kJ/kgk$

$C_v = 10.3\ kJ/kgK.$

(11 Marks)

Question THREE

(a) Define the following terms in reference to air standard cycles;

(i) Mean effective pressure,

(ii) Work ratio,

(iii) Cycle efficiency,

(iv) Compression ratio.

(4 Marks)

(b) An oil engine takes in air at 1.01 bar, 20 ^{o}C and the maximum cycle pressure is 69 bar. The compressor ratio is 18/1. Calculate the air standard thermal efficiency. Assume that the heat added at constant volume is equal to the heat added at constant pressure.

(16 Marks)

Question FOUR

(a) State the steady-flow energy equation and adapt it to steam turbine situation;

(4 Marks)

(b) Show that steady energy equation for CONSTANT PRESSURE flow process is given by:

$$dQ = \Delta h$$

where Q – heat transferred and h – enthalpy when there NO changes in potential and kinetic energies components.

(9 Marks)

(c) A stream of gases at 7.5 bar, 750'C and 140 m/s is passed through a turbine of a jet engine. The stream comes out of the turbine at 2.0 bar, 550'C and 280 m/s. The process may be assumed adiabatic. The enthalpies of gas at the entry and exit of the turbine are 950 kJ/kg and 650 kJ/kg of gas respectively.
Determine the capacity of the turbine if the gas flow is 5 kg/s.

(7 Marks)

Question FIVE

(a) With aid of p-v diagram derive heat transferred by superheated steam in an ISOTHERMAL process in terms of enthalpy, pressure and volume,

(6 Marks)

(b) In a steam engine cylinder the steam expands from 5.5 bar to 0.75 bar according

to a hyperbolic law, pv = constant. If the steam is initially dry and saturated, calculate per kg of steam:

(a) Work done ;

(b) Heat flow to or from the cylinder walls. (14 Marks)

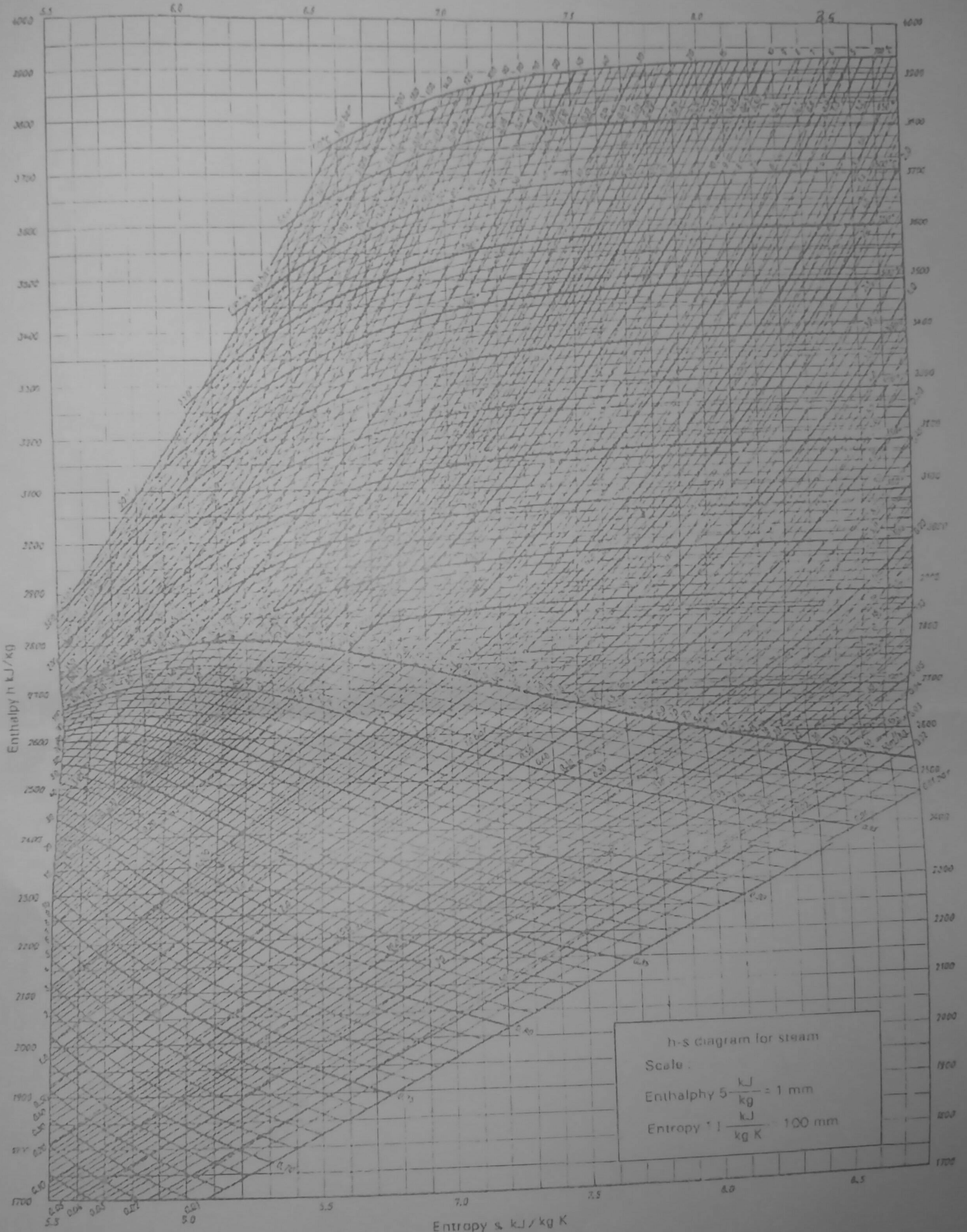


FIG. F-1 Mollier diagram for steam

TECHNICAL UNIVERSITY OF MOMBASA

School of Engineering and Technology

Department of Electrical & electronic Engineering

UNIVERSITY EXAMINATION FOR:

Bachelor of Science (Electrical & Electronic Engineering)

EEE 4403: CONTROL ENGINEERING I.

END OF SEMESTER EXAMINATION

SERIES: APRIL 2023 SERIES

TIME: 2 HOURS

DATE: APRIL 2023

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of five Questions; Question ONE is compulsory. In addition attempt any Other TWO Questions.

Do not write on the question paper.

Question ONE (Compulsory 30 marks)

a) The motor of the Figure Q1a is functioning under a constant field current. The parameters of the motor are:

$$R_a = 0.5\ \Omega, \quad L_a = 0.05\,\text{H}, \quad k_\omega = 2\,\text{V/r/s}, \quad k_t = 5\,\text{N}\cdot\text{m/A}, \quad \text{B} = 1\,\text{N}\cdot\text{m/r/s}$$

and $J = 45\,\text{N}\cdot\text{m/r/s}^2$

(i) Draw the block diagram and the SFG of the system.

(ii) Determine the transfer function $G(s) = \Omega(s)/V_i(s)$.

(iii) If $Vi(t) = 200u(t)$ V, compute the steady-state angular velocity of the motor

(iv) Determine the new steady-state velocity of the motor if a load torque $T'(t) = 40$ Nm is applied on the axis of the motor.

[25 marks]

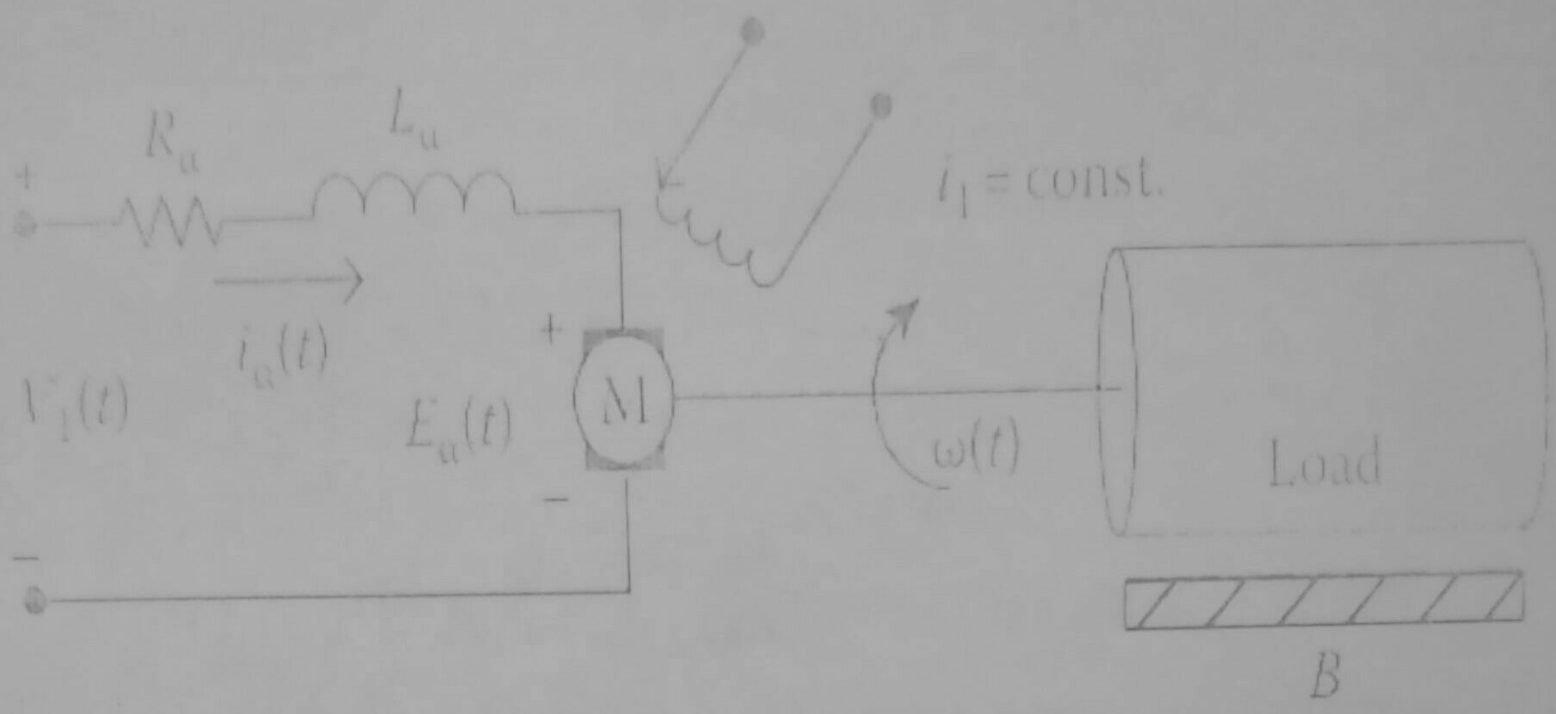


Figure Q1a

b) For a system with an open loop transfer function given by

$$G(s)H(s) = \frac{K}{s(s+1)(2s+1)}$$

i) Determine the stability when the value of K = 2

ii) Find the critical values of K for stability

[5 marks]

Question TWO

a) Compute the transfer function of the depicted block diagram of Figure Q2a

(i) By reduction

(ii) By plotting the relevant SFG and applying Mason's gain formula

[10 marks]

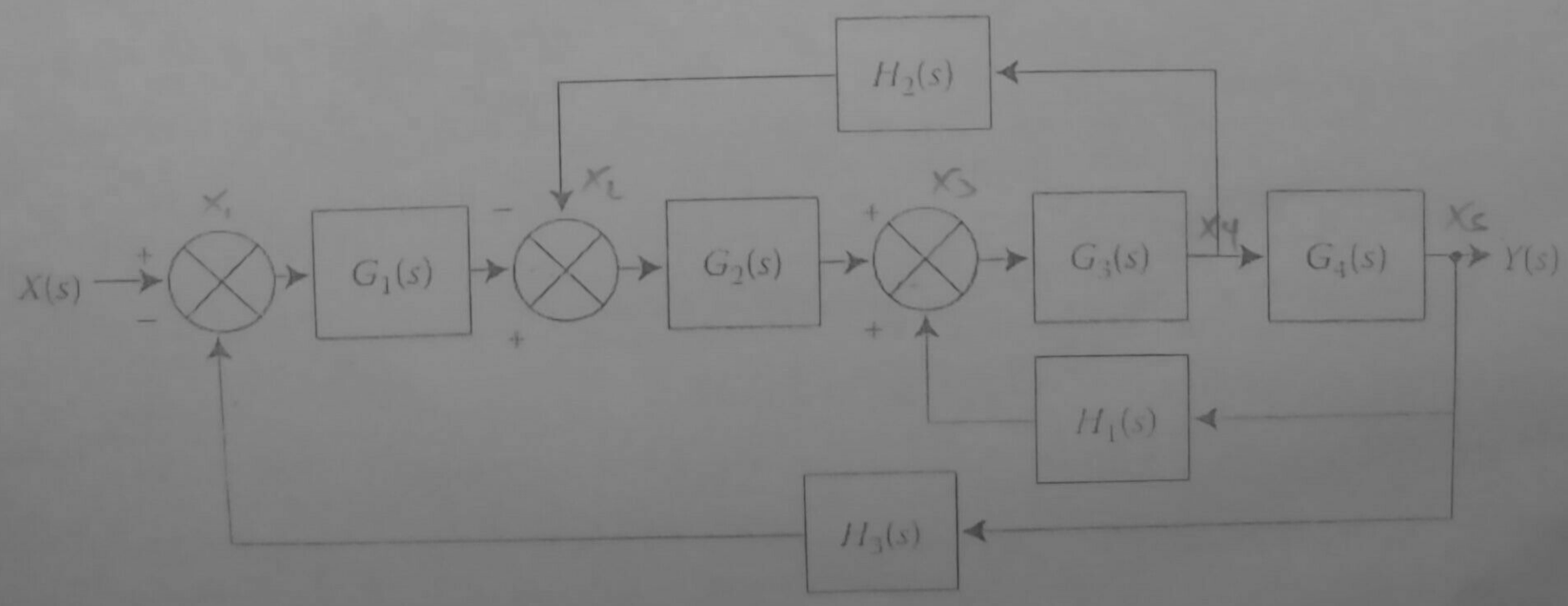


Figure Q2a

b) The equations that describe an automatic control system are

(i) Plot the SFG of the system.

(ii) Compute the transfer function G(s) = X5(s)/X1(s) of the system by applying Mason's

Gain formula.

[10 marks]

$$x_2 = x_1 t_{12} - x_2 t_{22} - x_4 t_{42} - x_3 t_{32}$$

$$x_3 = x_2 t_{23} - x_3 t_{33} - x_4 t_{43}$$

$$x_4 = x_2 t_{24} + x_3 t_{34} - x_4 t_{44}$$

$$x_5 = x_4 t_{45}$$

Question THREE

a) A system is described by the following differential equation

$$\frac{d^2y}{dt^2} + 5\frac{dy}{dt} + 16y = 9x$$

For a unit step input, determine;

i) Undamped natural frequency
ii) Damped natural frequency
iii) Damping ratio
iv) Rise time
v) Delay time
vi) Peak time
vii) Maximum percent overshoot
viii) Output

[16 marks]

b) State any Two advantages and two disadvantages of open loop control systems

[4 marks]

Question FOUR

a) Obtain the transfer function of the automobile suspension system in Figure 4Qa, the input u is a displacement input

[10 marks]

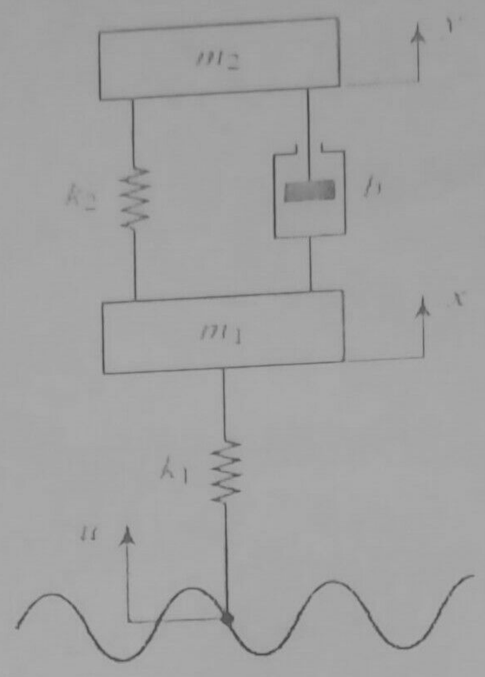


Figure Q4a

b) In the liquid level system of Figure Q4b the outflow rate Q m^3/sec through the outflow valve is related to the head H m by $Q = K\sqrt{H} = 0.01\sqrt{H}$ .Assume that when the inflow rate Q_i is 0.015 m^3/ sec the head stays constant . For $t < 0$ the system is at steady state ($Q_i = 0.015$ m^3/sec). At $t = 0$ the inflow valve is closed and so there is no inflow at $t \geq 0$. The capacitance C of the tank is $2m^2$ Find the time necessary to empty the tank to half its original head.

[10 marks]

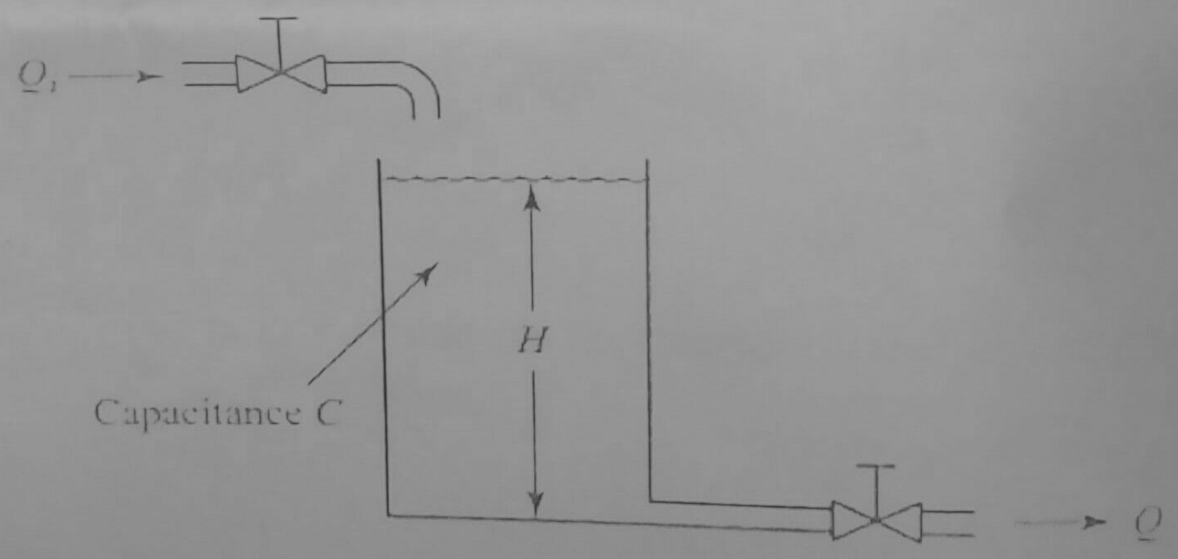


Figure Q4b

(Question FIVE

a) The block diagram of a space vehicle control system is shown in Figure 5Qa. Determine the value of K such that the phase margin is 50^0.

[6 marks]

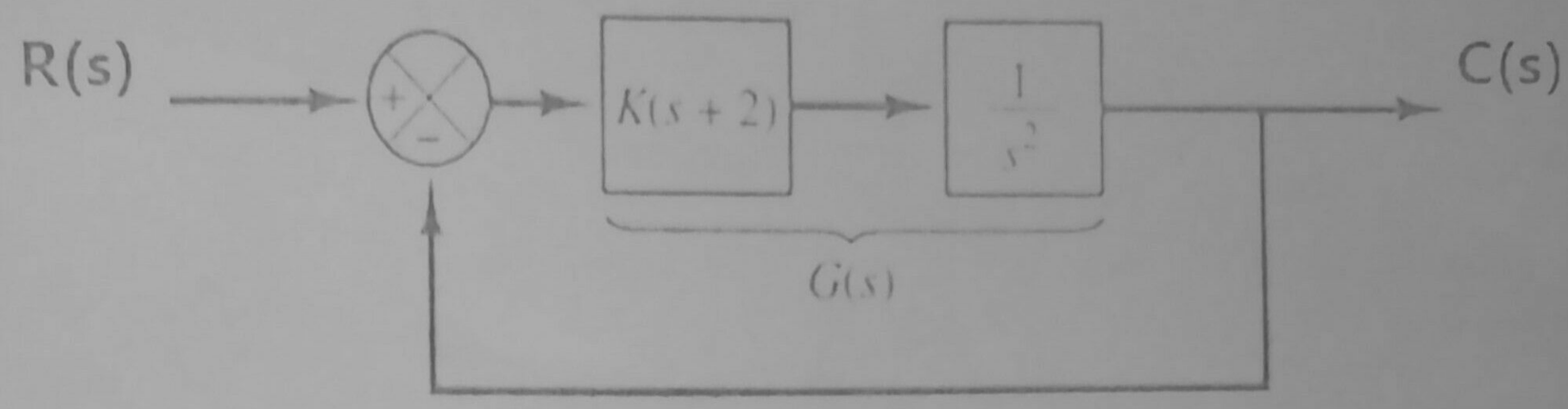


Figure Q5a

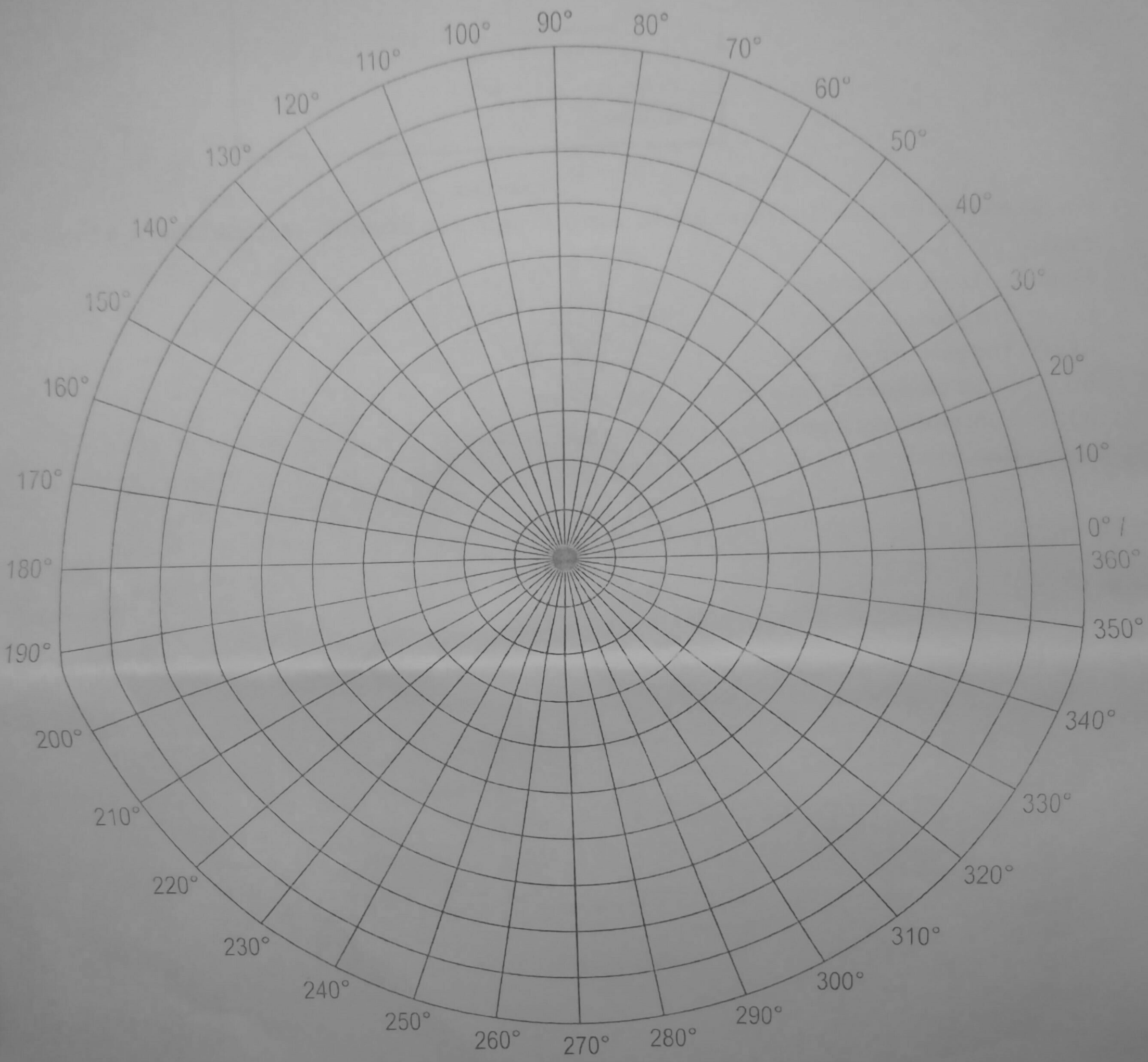
b) For the transfer function G(s) given below, sketch an open loop frequency response locus on a Nichols chart

From the sketch, determine:

i) The phase margin
ii) The gain margin
iii) Phase crossover frequency
iv) Gain crossover frequency
v) Bandwidth

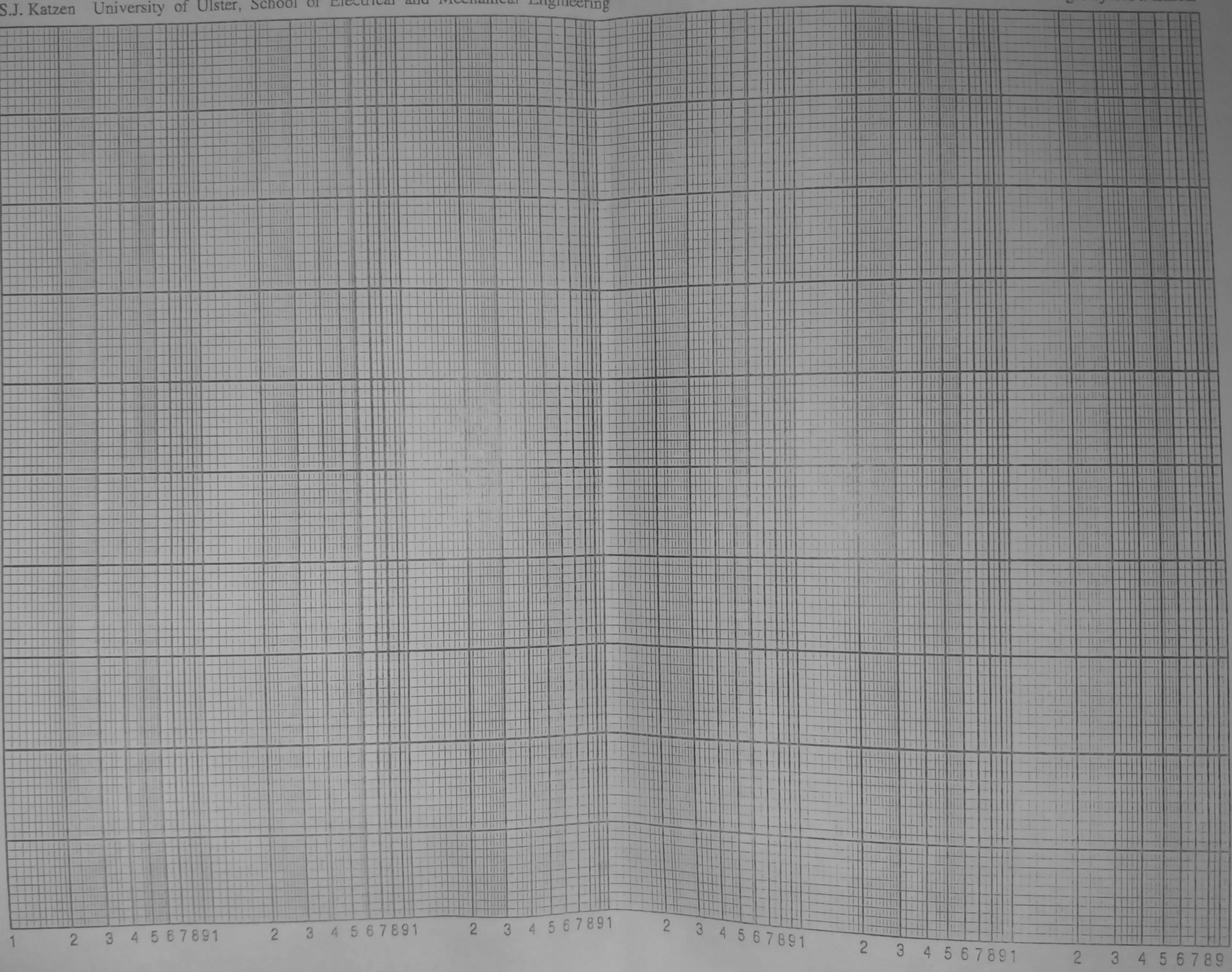
$$G(s) = \frac{1}{s(s+1)(0.5s+1)}$$

[14 marks]



S.J. Katzen University of Ulster, School of Electrical and Mechanical Engineering

Log 6 cycles x Linear



log6x0.ps

AutoCAD

PP1

TECHNICAL UNIVERSITY OF MOMBASA

School of Engineering and Technology

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

UNIVERSITY EXAMINATIONS FOR THE DEGREE OF BACHELOR OF SCIENCE IN ELECTRICAL & ELECTRONIC ENGINEERING

EEE 4304: ELECTRICAL MACHINES I

TIME: 2 HOURS SERIES APRIL, 2023

INSTRUCTIONS TO CANDIDATES

1. You are required to have the following for this examination;
   - Answer Booklet
   - A Non- Programmable Scientific Calculator
2. This paper consists of **FIVE** Questions.
3. Answer Question **ONE (COMPULSORY)** and any other **TWO** Questions
4. This paper consists of **FIVE** printed pages.

Question 1 (30 marks) (Compulsory)

(a) With the aid of diagram(s),describe how Induced voltage in the armature winding of DC motor is produced **(8 marks)**

(b) A shunt generator has field resistance of 60Ω. When the generator delivers 60kW the terminal voltage 120V, while the generated EMF is 135volts. Determine

(i) The armature circuit resistance

(ii) The generated EMF when the output is 20kw and the terminal voltage is 135volts.

(10 Marks)

(c) The open circuit and short circuit tests on a 10 kVA, 125/250 V, 50 Hz, single phase transformer gave the following results :

O.C. test: 125 V, 0.6 A, 50 W (on L.V. side)

S.C. test: 15 V, 30 A, 100 W (on H.V. side)

Calculate:

i) Copper loss on full load

ii) Full load efficiency at 0.8 leading p.f.

iii) Half load efficiency at 0.8 leading p.f.

iv) Regulation at full load, 0.9 leading p.f. **(12 Marks)**

Question 2 (20 marks)

(a) Derive the ARMATURE TORQUE of a DC Motor

(9 marks)

(b) Many applications require the speed of a motor to be varied over a wide range. One of the most attractive features of DC motors in comparison with AC motors is the ease with which their speed can be varied. Explain any THREE methods used for DC motor speed control.

(6 Marks)

(C) With the aid of a diagram describe the Swinburne's Test for DC Machines. **(5 Marks)**

Question 3 (20 marks)

(a) Define, using mathematical equations.

(i) flux density,

(ii) magneto motive force,

(iii) Magnetic field intensity,

(iv) permeability

(v) reluctance

(5 marks)

(b) A coil for a solenoid is 20 cm long and made up of 200 turns of wire. This wire has a dc resistance of 2.25Ω the solenoid is connected to a 100 V dc source. Determine;

(i) the MMF the coil produces and

(j) the magnetic field intensity

(6 marks)

(c) For the electric circuit analogy shown in Figure Q3 (C) with given Reluctances Determine.

(i) The current I

(ii) The flux Φ_2.

(iii) MMF drop across R_3 **(9 marks)**

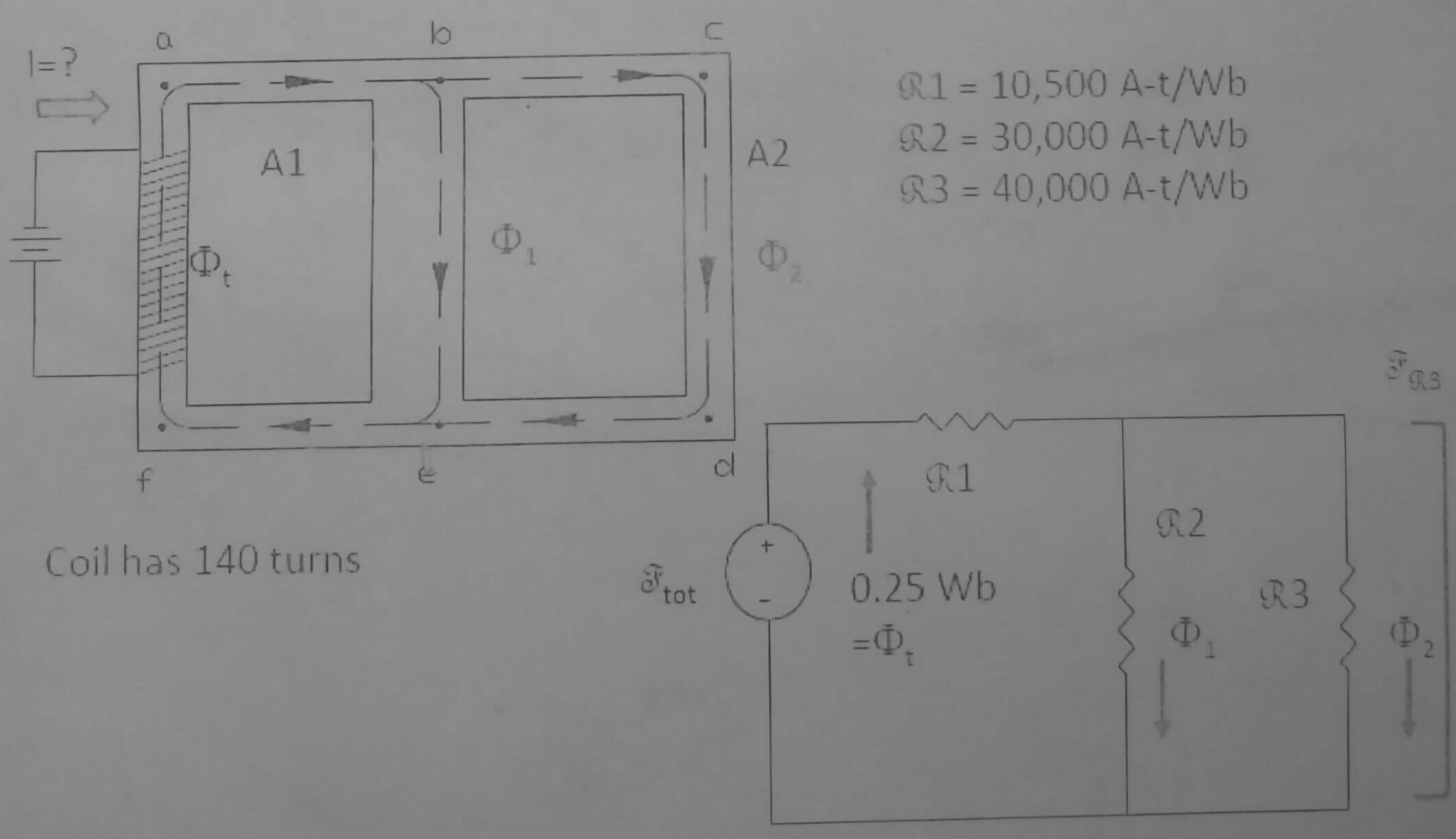


Figure Q 3 (C).

Question 4 (20 marks)

(a) Derive the emf equation of a single phase transformer.

(4 marks)

(b) With the aid of a phasor diagram explain the theory of a Transformer On Load, With Resistance and Leakage Reactance. **(7 Marks)**

(c) With the aid of a diagram describe the Sumpner's Test or Back-To-Back Test on Transformer. **(9 Marks)**

Question 5 (20 marks)

(a) A 240V, 20 HP 850rpm separately excited motor shown in Figure Q 5(a), draws 72A when operating at rated conditions. Determine the percentage reduction of the field flux necessary to obtain a speed of 1650rpm if the motor draws 50.4 amps at that speed.

(10 Marks)

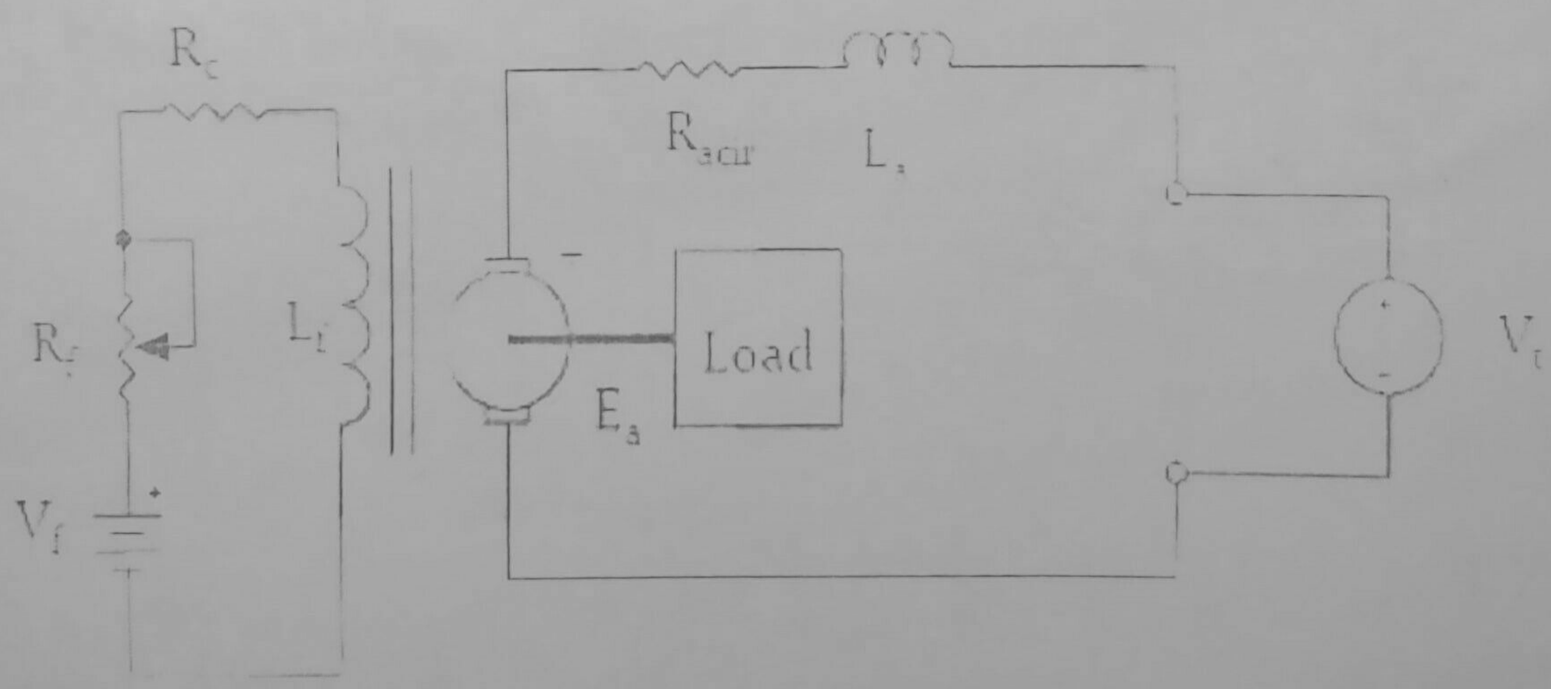


Figure Q 5(a)

(b) With the aid of a well labelled diagram describe the operation of a Three point DC motor starter

(6 marks)

(c) With the aid of a sketch describe the Duplex Lap Winding.

(4 marks)