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Tanta University
Faculty of Engineering
Electrical Power and Machines Engineering Dept.

Final Exam – First Semester 2022-2023

Course:	EPM2104 (Electromagnetic Fields)	**Time:**	3 hrs
Year:	2nd Electrical Power and Machines Dept.	**Date:**	21 Jan. 2023
Pages:	4 Pages	**Max Score:**	85

Remarks: Attempt to solve all of the following questions

Question 1: 21 Points (7,7,7)

(a) Starting with Gauss's law, deduce an expression for the resultant electric force on a positivecharge of 1C due to the electric field intensity of another point charge Q and infinite line charge with a charge density if ρ_L.

(b) Given that $V = x^2 y\,(z+3)$ V in free space. Find:

i) the electric flux density.

ii) the volume charge density at the origin.

iii) the electric flux through a cube of side 1 m and centered at the origin.

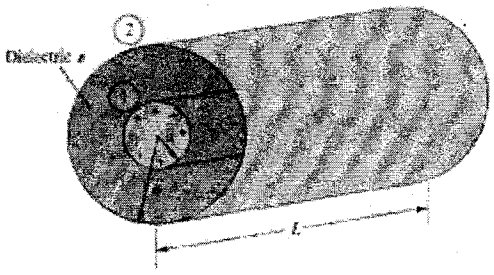
c) From the basic fundamentals of electrostatic field, deduce Ohm's law.

Question 2: 21 Points (7,7,7)

(a) Discuss the boundary condition between two dielectric materials illustrating the relation between the tangential and nominal values of electric field intensity and density.

(b) A point charge of $4\pi\varepsilon_0$ nC is located at point (5, 1, -1) in Cartesian coordinates in the presence of a perfectly conducting plane located at $z = 0$ in free space. Calculate the electric field intensity, the electric potential, and the surface charge density at (0,0,0).

(c) Deduce the capacitance of the coaxial capacitor illustrated in the figure.



Question 3: 43 Points (3,4*10)

(a) Write short note about Hall effect and how it can be used for current sensing.

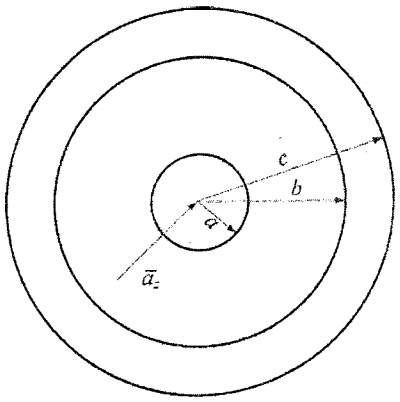
(b) A current sheet, $\bar{K} = 6\hat{a}_x$ A/m, lies in the $z = 0$ plane. If a current filament is located at y=0, z=4m; determine the filament current I and its directions, if **H** = **0** at (0, 0, 1.5) m.

(c) For a rectangle loop laying in xy-plane, the loop opposite corners are (0, 0, 0) and (1, -2, 0). It carries a filamentary current of 4mA. The current is going out the origin along negative x-direction. If the loop is subjected to the magnetic field:

$$\bar{B}_0 = -0.6\hat{a}_y + 0.8\hat{a}_z \text{T}$$

Calculate the torque established on the loop.

(d) Express the value of $\bar{H}$ in Cartesian components at P (0.01, 0, 0) m in the field of coaxial cable with radii a = 3 mm, b = 9 mm, c = 12 mm, I = 0.8A, centered on the z-axis, the positive unit vector $\hat{a}_z$ direction is into the central conductor.



(e) The point charge Q= 18nC has a velocity of 5×10^6 m/s in the direction:

$$\bar{B} = -0.6\hat{a}_x + 0.75\hat{a}_y + 0.3\hat{a}_z \text{ m/s}$$

Calculate the magnitude of the force exerted on the charge by the field:

i) $\bar{B} = -3\hat{a}_x + 4\hat{a}_y + 6\hat{a}_z$ mT

ii) $\bar{E} = -3\hat{a}_x + 4\hat{a}_y + 6\hat{a}_z$kV/m.

iii) $\bar{B}$ and $\bar{E}$ acting together.

With all best Wishes

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Tanta University

Department: Physics and Engineering Mathematics
Total Marks: 85 Marks

Faculty of Engineering

Course Title: Engineering Mathematics 3(a) Course Code: PME2109, : PME2110 Year: 2nd
Date: 9/1/ 2023 (First term) Allowed time: 3 hrs No. of Pages: (2)

Remarks: (answer the following problems… assume any missing data… answers should be supported by sketches)

Problem number (1) (43 Marks)

a) Find a spline of degree one to interpolate the following data and use the resulting spline to approximate $f(2.2)$

x	1	1.5	2	2.5	3
$y=f(x)$	1	3	7	10	15

b) Using forward, backward, and central methods to estimate the value of $f''(0.5)$ for the function $f(x)=x\cos x$ with $h=0.1$, and hence compare it with the exact value (-1.39764). In addition, find the truncation error for each case.

c) Deduce Trapezoidal Rule $I \cong \frac{h}{2}[f(x)+f(x-h)]$. Use the Composite Trapezoidal Rule with (n=6) to approximate $\int_0^3 x^2 e^x dx$ and find the true Truncation error.

d) Use the Mid-point Runge-Kutta method to obtain an approximation to the solution of the initial value problem (IVP) $\frac{dy}{dx}=(2x-y), x_o=0, y_o=-1$ To get the value of (y) at (x=1) with (n=10) compare the values of the exact solution:

$$y(x)=e^{-x}+2x-2$$

e) Solve the initial value problem (IVP) by using Adams Moulton 3-step implicit Method $\frac{dy}{dx}=(2x-y), x_o=0, y_o=-1$. To get the value of (y) at (x=1) with (n=10)

Problem number (2) (42 Marks)

a) Solve the following B V P:

$y''+(x+1)y'-2y=(1-x^2)e^{-x}, 0\le x\le 1$ With $y_0=-1, y(1)=0$, using the finite difference method with (h = 0.2) compare the results with the exact solution $y=(x-1)e^{-x}$.

b) If $u_t(x,t)=\alpha u_{xx}(x,t)$, $0<x<L$, $0<t<T$ Subject to the boundary conditions:
$u(0,t)=\alpha_0$, $u(L,t)=\beta_0$, $0\le t\le T$
and the initial conditions
$u(x,0)=f(x)$, $0\le x\le L$.
By using finite difference:

$u_t = \frac{u_i^{j+1} - u_i^j}{k}$ forward difference $\qquad u_{xx} = \frac{u_{i+1}^j - 2u_i^j + u_{i-1}^j}{h^2}$ centeral difference

Proof that $u_i^{j+1} = \lambda\left(u_{i+1}^j + u_{i-1}^j\right) + (1-2\lambda)u_i^j$

c) Solve the following PDE $u_t = u_{xx}, 0 \le x \le 1$, with initial condition $u(x,0) = x(1-x)$ and boundary condition $u(0,t) = u(1,t) = 0$ for all $t > 0$ use explicit method with $h = 0.25, \lambda = 0.25$ compute for four times.

d) If $u_{xx}(x,y) + u_{yy}(x,y) = G(x,y) \qquad a \le x \le b, \quad c \le y \le d$

subjected to the boundary conditions:

$u(x,c) = g_1(x), u(x,d) = g_2(x), a \le x \le b$

$u(a,y) = f_1(y), u(b,y) = f_2(y), c \le y \le d$

Use $u_{xx} \simeq \frac{u_{i+1}^j - 2u_i^j + u_{i-1}^j}{h^2}$

$u_{yy} \simeq \frac{u_i^{j+1} - 2u_i^j + u_i^{j-1}}{k^2}$

Proof that

$$-2\left(\frac{h^2}{k^2}+1\right)u_i^j + (u_{i-1}^j + u_{i+1}^j) + \frac{h^2}{k^2}(u_i^{j+1} + u_i^{j-1}) = h^2 G_i^j$$

e) Find the solution of Poisson equation using Standard five-points difference formula $u_{xx} + u_{yy} = G(x,y)$ in the region (R) subjected to the given boundary conditions :

$R: 0 \le x \le 3, 0 \le y \le 3, G(x,y) = x^2 + y^2 \rightarrow u(x,y) = 0$

Using $h = k = 1$

Note:

3- step Adams – Moulton Method:

$$y_{i+1} = y_i + \frac{h}{24}\left[9f_{i+1} + 19f_i - 5f_{i-1} + f_{i-2}\right] \rightarrow i = 2, 3, 4, \ldots..$$

Dr. Ashraf Al Mahalawy and the committee

TANTA UNIVERSITY
FACULTY OF ENGINEERING
DEPARTMENT OF ELECTRICAL POWER AND MACHINES ENGINEERING
EXAMINATION (SECOND YEAR) STUDENTS OF ELECTRICAL ENGINEERING

COURSE TITLE: ELECTRICAL POWER ENGINEERING (1)			COURSE CODE: EPM2105
DATE: 11/ 1/2023	TERM: FIRST	TOTAL ASSESSMENT MARKS: 90	TIME ALLOWED: 3 HOURS

Q1: (24 Marks)

A. Define the following terms:- **(8 Marks)**

i) Skin effect
ii) Ferranti effect
iii) Critical disruptive voltage
iv) Balancer machines set.

B. A three-phase, 50 Hz transmission line has the following parameters per phase: resistance = 6 Ω, inductance = 31.83 mH and capacitance = 1.06 μF. When the line is supplies a balance load of 100 MW at 132 Kv and power factor 0.8 Leading. Using the nominal π-method, Calculate: - **(16 Marks)**

i) ABCD constants of the line.
ii) Sending end voltage, current, power, and power factor.
iii) Transmission line efficiency and voltage regulation.
iv) Draw the complete Phasor diagram.

Q2: (20 Marks)

A. A single-phase AC distributing feeder 1 km long has a total per conductor resistance and reactance of 0.05 and 0.1 ohm/conductor, respectively. At the far end, the voltage is 250 Volt and the current is 120 A at a power factor of 0.8 lagging. At the mid-point, there is a load with a current of 90 A at a power factor of 0.6 leading. All power factors are with reference to the voltage at far end. Calculate: **(9 Marks)**

i) The voltage at the mid-point
ii) The voltage at sending end
iii) Draw the phasor diagram

B. Two-wire dc distributor AB is fed from both ends as shown in Fig. 1. The resistance per conductor is 0.0005 Ohm/m. Calculate the current in various sections of the feeder, the minimum voltage and the point at which it occurs in the system. Draw the load current and voltage drop diagrams. **(11 Marks)**

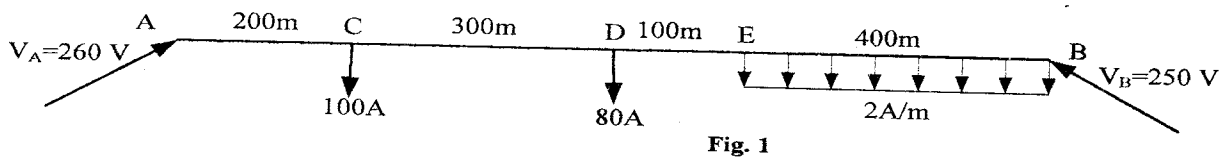

Fig. 1

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Q3: (26 Marks)

A. Mention the different methods used to improve the voltage distribution over string insulators in overhead transmission lines. Which method is practically used? **(6 Marks)**

B. Each line of a 3-phase system is suspended by a string of 3 similar insulators. If the voltage across the line unit (which connected directly to the line) is 17.5 kV, calculate the line to neutral voltage. Assume that the shunt capacitance between each insulator and earth is $1/8^{th}$ of the capacitance of insulator itself. Also, find the string efficiency. **(10 Marks)**

C. The towers of height 50 meters and 80 meters supports transmission line at a river crossing. The transmission line has a span of 600 meters between the supports. The weight of the conductor is 2 kg/m length, area of cross-section 2.5 square cm and has a breaking stress of 4200 kg/ square cm. If the conductor has ice coating of radial thickness 1.22 cm and is subjected to a wind pressure of 3.9 gm/ square cm, assume that the ice weight is 0.5 kg/m length. Find the minimum clearance of the conductor and the water level and the clearance mid-way between the supports. What is the vertical sag for a safety factor of 4? Bases the towers can be considered the water level. **(10 Marks)**

Q4: (20 Marks)

A. Derive an expression for the total power losses in a uniformly loaded distributor fed at both ends with equal voltages. **(7 Marks)**

B. Compare the volume of conductor material required in DC 2-wire system and DC 3-wire system assuming that: **(8 Marks)**

i) The amount of power P transmitted is the same
ii) The voltage V at the consumer's terminals is the same
iii) The efficiency of transmission is the same
iv) The area of X-section of neutral wire is the same of the outers.

C. Fill in the blanks by inserting appropriate words. **(5 Marks)**

i) The power loss in an overhead transmission line is mainly due to .....
ii) If the length of a transmission line increases, its inductance is .....
iii) The d.c. resistance of a line conductor of a 3-phase line is 5 μF, then capacitance of each conductor to neural is .....
iv) If the length of the line is decreased, its capacitance is .....
v) Transposition of a 3-phase transmission line helps in .....

Good Luck

Course Examination Committee: Assoc. Prof. **Hossam A. A. Saleh**

First Semester 2022-2023 | 2nd Year Elec. Power Students | Mechanical Engineering (MEP2141)
Final Term Exam (Saturday, 14/01/2023) | No. of Pages: 3 pages | Time allowed is 3 hrs

Notes for Students: (Steam tables are allowed)

- Answer **all** the following questions. The **maximum mark** of this exam paper is **70**.
- **Neat and clear** answers will be appreciated.

Question Number (1) (15 Points)

a) Discuss withdrawing the following: (10 points)

1- Non-slip condition
2- Newtonian's fluids
3- Uniform and Non-Uniform Flow
4- Degree of freedom in robotics
5- The basic hydraulic power circuit.

b) A dam with water of 120 m behind it is shown in **Fig. 1**. A turbine is used to generate electricity by permitting a water flow of 100 m^3/sec to flow, where it is connected to a generator with an efficiency of 80%. Assuming the hydraulic loss in the pipes and fitting to be 35 m. what is the electrical power that can be supplied by the turbine? (05 points)

Question Number (2) (15 Points)

a) A hydraulic is controlled using relays (classic control). Two limits switched are used to control the position of the cylinder by energizing the directional control valve. A start and stop switches are used. Draw the electrical circuit to control the system for continuous motion. (05 points)

b) The given **Fig. 2** shows the extension mode of a hydraulic cylinder. Neglecting the losses in the transmission lines and control valves, calculate the loading force, F, returned flow rate, Q_T, piston speed, v, cylinder output mechanical power, and pump output hydraulic power. Given: Delivery line pressure P = 200 bar , Pump flow rate QP = 40 L/min , Piston diameter D = 100 mm , and Piston rod diameter d = 70 mm. (05 points)

c) The slider–crank closed-chain mechanism is shown in **Fig. 3**. The mechanism consists of three revolute joints and one prismatic joint and four links. How many degrees of freedom for the system? (05 points)

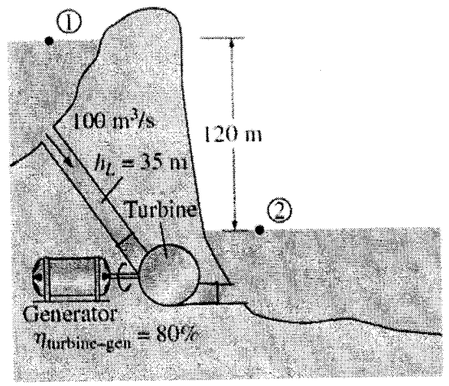

Fig. 1 - Problem No.1 (b)

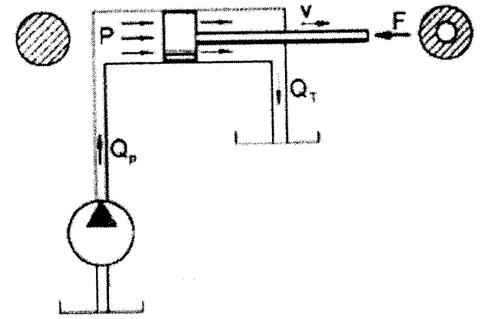

Fig. 2 - Problem No.2 (b)

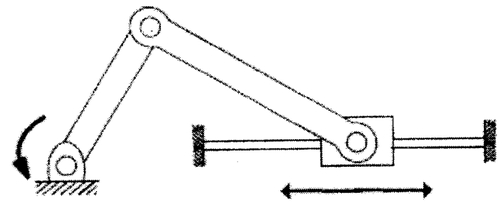

Fig. 3 - Problem No.2 (c)

Question Number (3) (13 Points)

a) Air is at an initial condition of 2 liter, 1.2 bar (abs) and 27°C in a cylinder-piston arrangement. It compresses till the final pressure reaches 10 bar (abs), calculate: a) the **mass** of the air in the cylinder; b) the **volume** and **temperature** at the end of the compression process in case of: [(1) an adiabatic compression process $PV^\gamma = C$ and (2) an isothermal compression process $PV = C$]. c) the compression **boundary work done** and **change in internal energy** within the cylinder in case of: [(1) an adiabatic compression process $PV^\gamma = C$ and (2) an isothermal compression process $PV = C$]. Sketch both processes on the (P-V) diagram and describe which one will consume more work done. For air: (C_V = 0.718 kJ/kg.K & C_P = 1.005 kJ/kg.K) (08 points)

b) Liquid water at 300 kPa and 20°C is heated in a chamber by **mixing** it with superheated steam at 300 kPa and 300°C. Cold water enters the chamber at a rate of 1.8 kg/s. If the mixture leaves the mixing chamber at 60°C, determine the mass flow rate of the superheated steam required. (05 points)

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Question Number (4) (16 Points)

a) A turbine operating under steady-flow conditions receives steam at the following state: pressure 13.8 bar, specific volume 0.143 m^3/kg, specific internal energy 2590 kJ/kg, velocity 30 m/s. The state of the steam leaving the turbine is as follows: pressure 0.35 bar, specific volume 4.37 m^3/kg, specific internal energy 2360 kJ/kg, velocity 90 m/s. Heat is rejected (loss) to the surroundings at the rate of 0.25 kW and the rate of steam flow through the turbine is 0.38 kg/s. Calculate the power developed by the turbine. **(06 points)**

b) A piston–cylinder device contains 0.8 kg of steam at 300°C and 1 MPa. Steam is cooled at constant pressure until one-half of the mass condenses. 1) Show the process on a T-v diagram. 2) Find the final temperature. 3) Determine the volume change. **(04 points)**

c) Complete the following table for water. In the last column describe the condition of steam as compressed (Subcooled) liquid, wet steam, superheated vapor, or saturated states. **Hint**: Complete in detailed steps are required. **(06 points)**

Case	T, (°C)	P, (bar)	v, (m^3/kg)	h, (kJ/kg)	Phase description and quality (if applicable)
1	.....	80	.....	3461	.....
2	.....	12	0.29464	.....	.....
3	310	.....	.....	2000	.....
4	50	.....	4.16	.....	.....

Question Number (4) (11 Points)

a) Define the following: Radiation heat transfer, Thermal conductivity of a material, Thermal insulators, Heat capacity, Thermal diffusivity, and Emissivity factor. **(03 points)**

b) Explain the mechanism of heat transfer by convection, classify convection heat transfer and mention all the variables influencing convection heat transfer coefficient. **(02 points)**

c) An insulated steam pipe having outside diameter of 3 cm is to be covered with two layers of insulation each having a thickness of 2.5 cm. The average thermal conductivity of one material is 5 times that of the other. Assuming that the inner and outer surface temperatures of composite insulation are fixed, how much will the heat transfer be reduced when the better insulating material is next to the pipe than it is outer layer? **(06 points)**

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TANTA UNIVERSITY

Electrical Power and Machines
Engineering Department

Faculty Of Engineering

Final EXAM 2022/2023 - First Term

Course	Energy Conversion (EPM2106)	Time	3 hours
Students	2nd Year (Electrical Power and Machines)	Mark	90
Date	18/01/2023	Number of pages	4

Answer ALL the following questions:

The first question (24 marks)

A **Choose the correct answer and put it in the answer sheet.**

1. The source of the magnetic field is the ……..
(a) magnetic flux (b) electric field (c) magneto-motive force (d) magnetic field intensity

2. The ratio between the flux linking the coil and the current is known as ……
(a) flux linkage (b) stored energy (c) inductance (d) flux density

3. Statically-induced emf depends upon the time variation of the …..
(a) supply voltage (b) coil current (c) inductance (d) both (b) and (c)

4. The …… reflects the effect of current variation in a coil on the induced emf in another coil.
(a) stored energy (b) self-inductance (c) magneto-motive force (d) mutual inductance

5. If the magnetic material has a high value of relative permeability, high values of flux density can be obtained for relatively low values of……
(a) induced emf (b) stored energy (c) coil current (d) magnetic flux

6. If the material has constant ……. in all the range of the field intensity, the material is known as a *linear material.*
(a) induced emf (b) magneto-motive force (c) stored energy (d) permeability

7. If the flux intensity is produced by……, the complete B-H relation during one cycle of current is known as "*hysteresis loop*".
(a) dc current (b) battery (c) ac current (d) all of the above

8. The ……. is the part of the magnetic flux that goes beyond the boundaries of the magnetic path.
(a) linkage flux (b) iron losses (c) magnetic flux fringing (d) leakage flux

9. The point of …… permanent magnet volume is called the point of maximum energy product.
(a) maximum (b) same (c) minimum (d) none of the above

10. Eddy currents circulate in the material in such directions to oppose the change in the …….
(a) resistance (b) stored energy (c) flux (d) reluctance

11. A demagnetizing effect results from the eddy currents in the magnetic material, which causes an increase in the ……
(a) flux density (b) load current (c) dynamically-induced emf (d) exciting current

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12. The coupling coefficient between two magnetically-coupled coils cannot exceed unity because the permeances of the leakage paths and the mutual permeances are always ……
(a) zero (b) negative quantities (c) equal quantities (d) positive quantities

13. The mutually coupled coils are considered ideal, if the self-inductances approach ……
(a) zero (b) equal quantities (c) infinity (d) none of the above

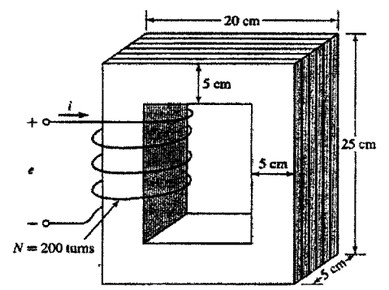
14. The part which provides a stabilized voltage in the photovoltaic generating system is ……
(a) solar array (b) charging unit (c) battery (d) inverter

15. The wind-turbine rotation speed depends on the …… in a reverse sense.
(a) wind speed (b) turbine diameter (c) tip-speed ratio (d) power coefficient

16. For a certain range of wind speed and using the variable pitch angle turbines, the generator speed can be ……..
(a) increased (b) kept constant (c) reduced (d) reversed

17. The pitch angle mechanical control may be used to follow the points of ……in order to extract the maximum energy from the wind.
(a) high wind speeds
(b) large turbine diameter
(c) optimum tip-speed ratio
(d) zero pitch angle

B The given magnetic core is made from laminations of M-5 grain-oriented electrical steel. The winding is excited with a 60-Hz voltage to produce a flux density in the steel of B= 1.5 sin ωt Tesla, where $\omega=2\pi 60 \approx 377$ rad/sec. The steel occupies 0.94 of the core cross-sectional area. The mass-density of the steel is 7.65 g/cm3. At 1.5 Tesla peak flux density, the exciting voltamperes per kilogram is 1.5 VA/kg and the magnetic field intensity is 36 A.turns/m.



Solve the above problem to determine the following then choose the closest answer and put it in the answer sheet (حل المسألة فى كراسة الإجابة أولا ثم أختار الناتج المناسب).

18. The peak applied voltage is
(a) 376 V (b) 266 V (c) 188 V (d) 1.33 V

19. The peak current is
(a) 0.063 A (b) 0.122 A (c) 0.13 A (d) 0.092 A

20. The rms exciting current equals
(a) 0.13 A (b) 0.1 A (c) 0.26 A (d) 0.071 A

The second question (24 marks)

A Derive mathematical relations to determine **speed voltage** for both singly and multiply-exited systems. **Define clearly** all employed symbols. (4 marks)

B With the aids of current-flux linkage curves, **derive** how to determine energy converted into mechanical motion from a certain position to another. (4 marks)

C For a *rotating* nonlinear system, with the aids of current-flux linkage curves show graphically the following quantities (***Use a separate sketch for each case)***: (8 Marks)

(1) **Input electrical energy** to when current changes from I_1 to I_2 for the following cases:
   a) Fixed system
   b) Moving system from θ_1 to θ_2 where $\theta_1 > \theta_2$, assuming current I_1 (at θ_1) is zero.

(2) The initial and final amounts of **stored energy** when current changes from I_1 to I_2 while position changes from θ_1 to θ_2

(3) the amount of converted energy into **mechanical** form when current changes from I_1 to I_2 while position changes from θ_1 to θ_2 assuming very slow motion for the following cases:

a) $I_2 > I_1$ b) $I_1 = I_2$

D Repeat part (C) for a linear system. Then, derive a mathematical relations of each quantity in terms of current, flux linkage and inductance. (8 Marks)

The third question (24 marks)

A Define **co-energy**. Then **derive** in details how it can be used to obtain **the force** developed in a singly-excited electromechanical energy translational converter. Show how to determine direction of motion in linear cases. (5 Marks)

B An electromagnet of 5 cm^2 cross-section area and 1000 turns coil is used to control a relay. The magnet has an air gap length of x. Assume that the reluctance of the iron parts is negligible. It is required to develop a constant force of 50 N: (5 Marks)

a) For a range of $x < 5$ mm, plot the relation between x and both the required current and corresponding stored energy

b) If the coil current *has not to exceed* 2 A, what is the range of x?

C A doubly-excited rotating system with saliency associated with both the stator and the rotor. It has the following parameters assuming sinusoidal inductance variation: (8 Marks)

	Stator	Rotor
Maximum self-inductance, H	1.2	0.9
Minimum self-inductance, H	0.4	0.3
DC current, A	10	5
Maximum mutual inductance, H	0.6	

a) Plot as accurate as possible the variation of torque against rotor angular position.

b) Determine the positions of maximum torque and the corresponding torque.

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D a) Using suitable relations (without derivation), show how to determine the rms value and frequency of phase voltage induced in a coil subjected to time a varying flux of a sinusoidal form. Define all quantities.

b) Explain (with simple illustrations) what is meant by distributing and chording electrical machine windings?

c) Define *specific electric loading* and *specific magnetic loading*. Then, show with suitable relations how they *affect the main dimensions* of an electrical machine.

The fourth question (18 marks)

A For a doubly-excited electromechanical energy conversion device of **cylindrical stator** and **salient-pole rotor**: (10 Marks)

a) Sketch the space variation of self and mutual inductances.

b) Derive a general expression for the electromagnetic torque acting on the rotor.

c) Show all the possible electrical machines can be obtained.

B Show the MMF space distribution a dc-excited coil of uniform air gap, if the conductors are:

a) concentrated b) distributed in 8 slots (4 in each side).

Which of the two cases are preferred? Why? (4 Marks)

C Show that balanced three-phase windings excited by balanced three-phase currents produce a single rotating MMF wave. (4 Marks)

Good Luck

Prof. Essam Eddin M. Rashad *Dr. Mohamed Gamal Hussien*