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

Final Exam – First Semester 2021-2022

Course: EPM2104/EPM2141(Electromagnetic Fields)	**Time allowed:** 3 hr
Year: 2nd Elec. Power / Communications Eng.	**Date:** Jan 12, 2022
No. of Pages: 2	**Total Score:** 85

Remarks: Attempt to solve all of the following questions

Question 1 — **24 Points**

Choose the correct answer for the following statements:

(Verification of your choice is A MUST when numerical data are given)

(1) Electric _____ at a point may be defined as equal to lines of force passing normally through a unit cross-section at that point

(a) field intensity (b) flux (c) flux density (d) potential

(2) Plane z = -10 m carries charge -20 nC/m². The electric field intensity at the origin is

(a) $-10a_z$ V/m (b) $-18\pi a_z$ V/m (c) $360\pi a_z$ V/m (d) $-360\pi a_z$ V/m

(3) An infinite sheet has a charge density of 150 μC/m². The flux density in μC/m² is ____.

(a) 50 (b) 75 (c) 100 (d) 1/75

(4) Point charges 30 nC, -20 nC, and 10 nC are located at (-1,0,2), (0,0,0), and (1,5,-1) , respectively. The total flux leaving a cube of side 6 m centered at the origin is:

(a) -20 nC (b) 20 nC (c) 10 nC (d) 30 nC

(5) A potential field is given by $V = 3xy - 5y$. Which of the following is not true?

(a) The potential difference between point (2, -1, 4) and point (2, -1, -4) is zero.
(b) At point (1, 0, -1), E vanish.
(c) The electric field at (2, -1, 4) is $3a_x - a_y$ V/m.
(d) The potential at (0, 1, 0) is -5 V.

(6) Which is not an example of convection current?

(a) Electric current flowing in a copper (b) A beam of moving charges
(c) Electronic movement in a vacuum tube (d) An electron beam in cathode ray tube

(7) The relaxation time of a material having $\sigma = 10^{-17}$ mho/m and $\varepsilon_r = 5$ is

(a) 5×10^{-10} seconds (b) 10 minutes (c) 15 hours (d) 51.2 days

(8) In a dielectric material an applied field in x direction $E_x = 6$ V/m gives a polarization of $P_x = 1/(6\pi)$ nC/m². The permittivity of the material is ____ pF/m.

(e) 1 (f) 2 (g) 17.68 (h) None of these

(9) Electric field inside a hollow metallic charged sphere is ____.

(a) increasing towards (b) decreasing towards (c) still (d) None of

(10) A capacitor connected to a battery stores energy twice as much with a given dielectric as it does with air. The susceptibility of the dielectric is

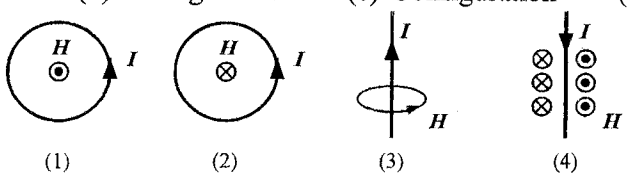
(e) 0 (f) 2 (g) 1 (h) 3

(11) The electrostatic field is _____ field.

(a) conservative (b) non-conservative (c) solenoidal (d) None of these

(12) Identify the configuration in the figure that is not a correct representation of I and H

(a) Configuration (b) Configuration (c) Configuration (d) Configuration



(1) (2) (3) (4)

Question 2 — **14 Points**

State true (√) or false (×) and **correct the false statements**

(1) Both ε_o and χ_e are dimensionless.

(2) The electric flux density on a spherical surface r = b produced by a point charge Q located at the origin is the same as that produced by a charge of the same value as Q but distributed over the surface r=a where a<b.

(3) Inside a conductor, the electric field intensity is changes with the position.

(4) A conductor is an equipotential body.

(5) The dielectric strength is the maximum magnetic field that a dielectric can tolerate or withstand without breakdown.

(6) For a free-charged dielectric-dielectric interface, the tangential components of the electric flux density in the two materials are equal.

(7) An isolated magnetic pole exists.

Question 3 — **20 Points (10+10)**

[A] A uniform surface charge density $\boldsymbol{\rho_s}$ is distributed over a cylindrical surface of radius $\boldsymbol{a}$ and extending from $\boldsymbol{z = -h}$ to $\boldsymbol{z = h}$. Find (a) the total charge on the finite cylindrical surface. (b) the electrostatic force on a unit positive charge located in free space at (0,0,k).

[B] Planes $x = 2$ and $y = -3$ respectively carry the same charge of $10/\pi$ nC/m^2. If the line $x = 0$, $z = -2$ carries charge 10 nC/m, calculate the electrostatic field intensity at the point (0,1,-1) due to the charge distributions.

Question 4 — **27 Points (6, 15, 6)**

[A] An infinitely long straight filament carries current of (I) lies in free space along z-axis.

(a) Use Biot-Savart's law to obtain the magnetic field intensity and the magnetic flux density at point (0,4 meters,0).

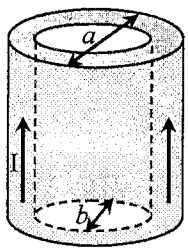
(b) Determine the force, $\bar{F}$ exerted on the filament if the area surrounding it has a magnetic flux density of $\bar{B} = \hat{a}_x - \hat{a}_y$ wb/m^2. (Use the following relation, $\bar{F} = \oint I\bar{dL} \times \bar{B}$)

[B] Consider an infinite length hollow conducting tube of conductivity σ_1 S/m carrying a current I with a uniform current density as shown in the figure.

(i) Apply Ampere's law to derive expressions for the magnetic field intensity everywhere and sketch the results as a function of the radius r

(ii) Derive a formula for the resistance per unit length of the tube

(iii) The space 0 < r < b is now filled with a conducting material whose conductivity is σ_2 S/m. Current I in Ampere, flows through the area $0 < r < a$ with a constant current density. Derive a formula for the voltage drop across each unit length of the filled tube



[C] Write down Maxwell equations for steady magnetic field and static electrical field in both differential and integral forms. Explain the modifications required for time varying fields.

Wish you all the best **Dr. Mohamed Elnemr and Dr. Sherif Dabour**

Tanta University

Department: Elec. Power and Machines Engineering

Total Marks: 90 Marks

Faculty of Engineering

Title: Electrical Power Engineering (1)	**Course Code: EPM2105**	**Year: 2nd year**
Date: January 26th 2022 (First term)	**Allowed time: 3 hrs**	**No. of Pages: (2)**

Problem number (1) (25 Marks)

a) Write short notes on the following:
i. Skin effect
ii. Transposition of conductors
iii. Guard ring (6 Marks)

a) 50-Hz double-circuit 3-phase line arranged as shown in Fig. 1. The conductors are completely transposed and are of radius 1 cm each. Find,

- The inductance per phase per km and inductive reactance.
- The capacitance per phase per km and the charging current at 138 kV. (10 Marks)

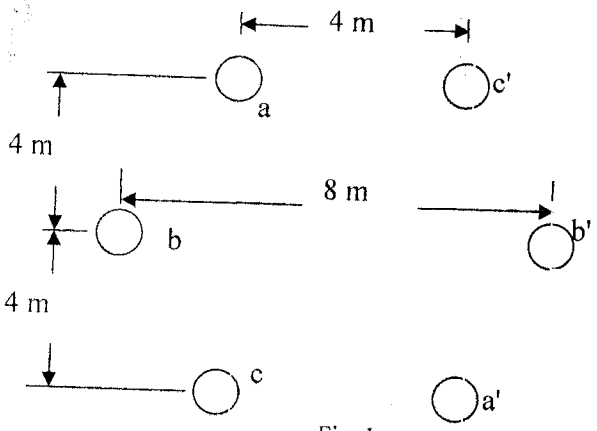


Fig. 1

b) A 3-phase transmission line delivers a load of 50 MW at 132 kV' and 0.8 lagging power factor. The generalized constants of the transmission line are: $A = D = 0.95\angle 1.4°$; $B = 96\angle 78°$; $C = 0.0015\angle 90°$. Find the regulation of the line, the efficiency and the charging current. Use nominal-T method, draw the phasor diagram of the system for load of lead power factor comment on the voltage regulation of the system in this case. (10 Marks)

Problem number (2) (20 Marks)

a) Explain the essential mechanical considerations for transmission lines design. (5 Marks)
b) Mention the different methods used to improve the voltage distribution over string insulators in overhead transmission lines. Which method is practically used? (5 Marks)
c) Each conductor of a three phase high voltage transmission line is suspended by a string of 4 suspension type disc insulators. If the potential difference across the second unit from the top is 13.2 KV and across the third from top is 18 kV. Determine the voltage between conductors and string efficiency. (10 Marks)

Problem number (3) (20 Marks)

a) **Decide whether the following statements are correct or false. (*Correct the false statements*): (10 points)**

1- If the spacing between the conductors is increased, then effect of corona discharge is reduced.
2- The rated voltage of the transmission line is the voltage at which corona discharge is just initiated.
3- If sag in an overhead line increases, tension in the line decreases.
4- Sag is provided in overhead lines so that safe tension is not exceeded and repair can be done.
5- Service mains connects the distribution substation to the area where power is to be distributed.
6- The main advantage of ring main system over radial system is that power factor is higher.
7- The underground cable system has an expensive initial cost, high current carrying capacity and more safe than the overhead line system.
8- The maximum voltage drop of a uniformly loaded DC distributor which is fed at both ends with equal voltages is one fourth its value for a similar distributor fed at one end only.
9- The null point of a uniformly loaded distributor feed at equal voltage at both ends lies at either end.
10- In AC (DC) distribution calculations, additions and subtractions of currents are done arithmetically.
11- Main reasons for the use of DC system for the distribution includes advancements in power electronics and the rapid growth of solar and wind energy sources.
12- Electrical energy is often generated, transmitted, and distributed in the form of AC as only technical considerations.

b) An overhead transmission line conductor at a river crossing is supported from two towers at heights of 30 m and 90 m above the water level as shown in Fig. 2. The horizontal distance between the towers is 500 m and the cross-sectional area of the conductor is 2 cm^2. The weight of conductor is 1.25 kg/m, and the wind pressure is 0.83 kg/m. If the ultimate strength is 4000 kg/cm^2 and safety factor is 5, **find** (i) the minimum clearance at point O of the conductor and water, and (ii) the vertical sag at mid-point P. **(10 points)**

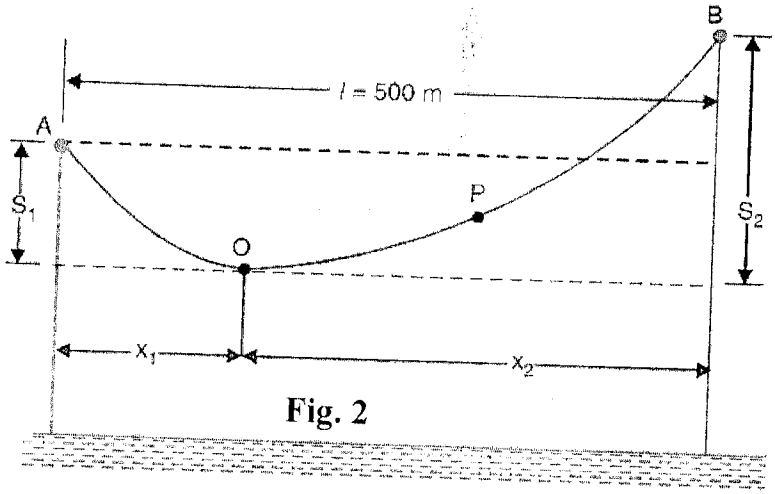


Fig. 2

Problem number (4) (25 Marks)

a) A 2-wire D.C. distributor AB is 500 m long and is fed at both ends at 240 V. The distributor is loaded with both concentrated and uniform loading as shown in Fig. 3. The resistance of each conductor is 0.5 Ω per km. **Calculate** (i) the point of minimum voltage and (ii) the value of this voltage.**(15 points)**

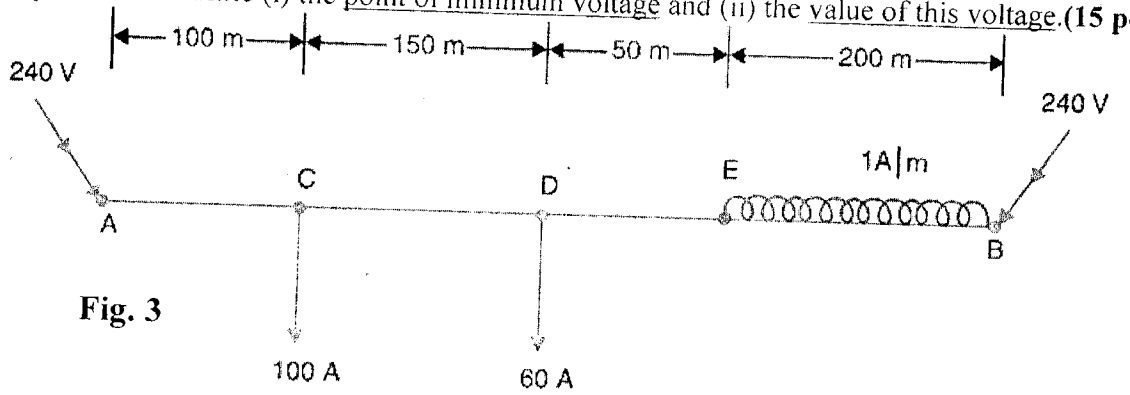


Fig. 3

b) A 3-ϕ, 400 V distributor AB has 1.0 km long. At 0.6 km from the feeding point, a 3-ϕ load is tapped which takes 5 A per phase at a power factor of 0.8 lagging. At the far end of the distributor, a 3-ϕ, 400 V, star-connected induction motor is tapped which has an output of 10 HP with an efficiency of 90% and power factor of 0.85 lagging. If voltage at motor terminals is to be maintained at 400 V, **what** should be the voltage at feeding point? The resistance and reactance of the line are 1 Ω and 0.5 Ω per phase per km, respectively. **(10 points)**

Course Examination Committee: Dr Ahmed E. ELGebaly, Dr Mohamed Elkadeem

Tanta University

Department: Physics and Engineering Mathematics
Total Marks: 85 Marks

Faculty of Engineering

Course Title: Engineering Mathematics 3(a)	Course Code: PME2111	Year: 2nd
Date: 30/1/ 2022 (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) (63 Marks)

a) Find the polynomial of degree ≤ 3 that interpolates the following data using Lagrange interpolation.

x	1.2	2.1	3	3.6
y	0.7	8.1	27.7	45.1

b) Prove that $f''(x) \approx \frac{f(x+h)-2f(x)+f(x-h)}{h^2}$ and $T.E \leq \frac{h^2}{12}\left|f^{(4)}(c)\right|, \quad x-h \leq c \leq x+h$

c) Use Gaussian quadrature (2- points, and 3- points) formula to evaluate the integral $I = \int_0^1 \frac{dx}{1+x^2}$ then determine the absolute error.

d) Solve the initial value problem (IVP) by using Euler method $\frac{dy}{dx} = (2x - y), x_o = 0, y_o = -1$. To get the value of (y) at (x=0.5) with (h=0.1) compare the values of the exact solution $y(x) = e^{-x} + 2x - 2$.

e) Take the case of a pressure vessel that is being tested in the laboratory to check its ability to withstand pressure. For a thick pressure vessel of inner radius a and outer radius b, the differential equation for the radial displacement u of a point along the thickness is given by

$$\frac{d^2u}{dr^2} + \frac{1}{r}\frac{du}{dr} - \frac{u}{r^2} = 0$$

The inner radius $a = 5''$ and the outer radius $b = 8''$. The boundary conditions are:

$$u\big|_{r=a} = 0.0038731"$$

$$u\big|_{r=b} = 0.0030769"$$

Divide the radial thickness of the pressure vessel into 6 equidistant nodes. Solve by using finite difference method. Take $\frac{du}{dr} \approx \frac{u_{i+1} - u_i}{\Delta r}$

f) Find the numerical solution of wave equation $\alpha^2 u_{xx}(x,t) = u_{tt}(x,t), \quad 0 < x < l, \quad 0 < t < T$ Using implicit method.

Note that at $j=0$ use $2u_i^1-\lambda^2(u_{i+1}^1-2u_i^1+u_{i-1}^1)=2f_i+2k\,g_i-k\lambda^2(g_{i+1}+2g_i+g_{i-1})$

g) Approximate the solution of the wave equation $u_{xx}=u_{tt}$, $0<x<1$, $t>0$ subjected to the initial and boundary conditions:

$u(x,0)=\sin(\pi x)$, $0\le x\le 1$

$u_t(x,0)=0$, $0\le x\le 1$

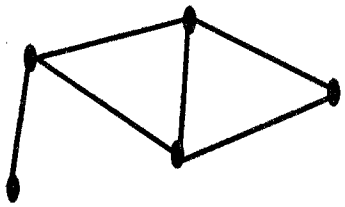
$u(0,t)=u(1,t)=0$, $t>0$

Use the implicit method with using $h=k=0.25$

Problem number (2) (22 Marks)

a) Use graph vertices counting to find value of 253* 32

b) From the following graph find connectivity k(G) ε(G), d(G), g(G)and diam(G)

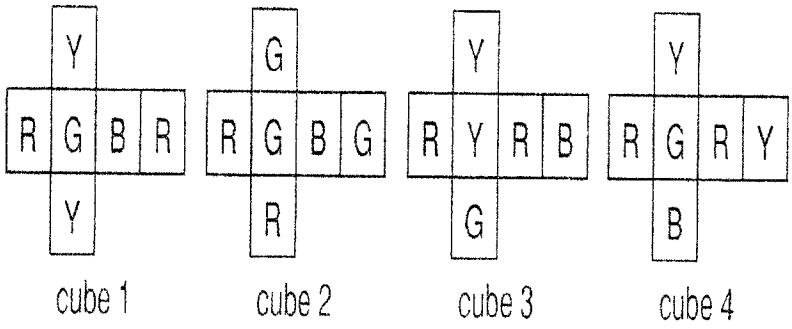


c) Show that every graph G=(V,E) contains a cycle satisfy
$g(G)\le 2\,\mathrm{diam}(G)+1$

d) Find binary tree with vertices 2,4,6,8,10,12,14,16 with root 8 then delete · (12) and insert (11)

e) Consider isomorphic degree sequence of graph 5,4,3,3,2,2,1,1 use dilation isomorphic theory to find the smallest graphical graph the obtain every graphs corresponding each steps.

f) Use graph theory concepts to put 4 cubes whose faces are colored red ,blue .green and yellow in 4X1 stack so that all four colors appear on each side of stack



Tanta University

Electrical Power and Machines Engineering Department

Faculty of Engineering

Course Title: Civil Engineering	**Academic Year 2021/2022** **First Term Exam**	**Course Code: CSE2155**
Year: Second		**Total Marks: 70 Marks**
Date: 2-February-2022	**No. of Pages (2)**	**Allowed time: 3 hrs**
Remarks: (answer all the following questions, and assume any missing data) (answer should be supported by sketches)		

السؤال الأول (٢٠ درجة)

١. أدى التطور الهائل في علوم الحاسب وكذلك انتشار استخدام صور الأقمار الصناعية إلي تغير مفهوم علم المساحة. اشرح العبارة موضحاً أهمية علم المساحة. **(٣ درجات)**

٢. اذكر العوامل التي يتوقف عليها اختيار مقياس الرسم مع توضيح تأثير كل عامل من هذه العوامل علي اختيار مقياس الرسم المناسب للخريطة. **(٣ درجات)**

٣. وضح بالرسم كيفية قياس الزوايا بين أضلاع الترافرس باستخدام أدوات قياس الأطوال فقط. **(٣ درجات)**

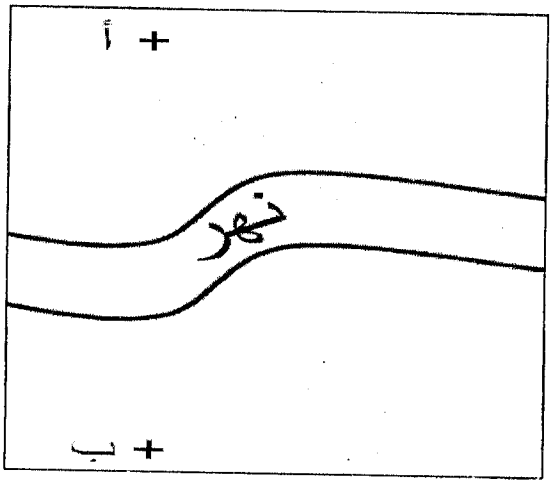
٤. اذكر أهمية وأهداف الميزانية وكذلك الأدوات المستخدمة في عمل الميزانية. **(٥ درجات)**

٥. طريق طوله ١,٢ كم وطوله علي الخريطة ٢٤ سم. صمم مقياس رسم تخطيطي لتلك الخريطة يقرأ إلي أقرب ٤ ذراع ثم بين القراءة ٢٨٨ ذراع معماري علي المقياس. **(٦ درجات)**

السؤال الثاني (١٥ درجة)

١. اوصف مع الرسم كيفية قياس مسافة على أرض غير منتظمة الانحدار. **(٤ درجات)**

٢. يوضح الشكل النقطة (أ) على أحد جانبي نهر والنقطة (ب) على الجانب الاخر من النهر. وضح بالرسم مع كتابة المعادلات كيف يمكن قياس المسافة الأفقية (أب) من نقطة (أ) حيث لا يمكن الوصول لنقطة (ب). **(٤ درجات)**



٣. شريط طوله ١٠٠ متر تمت معايرته وهو مستند علي كامل طوله في درجة حرارة ٦٨ درجة فهرنهيت (معامل التمدد الحراري لمادة الشريط = ٦٤٥* ١٠^-٨ لكل درجة فهرنهيت) فإذا استخدم هذا الشريط لقياس طول خط وكان فرق الأرتفاع بين طرفي الخط يساوي ٨ متر ودرجة حرارة القياس ٨٠ درجة فهرنهيت وكان الطول المقاس للخط ٤٥٠ متر. المطلوب حساب الطول الحقيقي للشريط إذا كان الطول الحقيقي للخط ٤٤٩,٤٢ متر. **(٧ درجات)**

السؤال الثالث (٢٠ درجة)

أخذت القراءات الأتية بالأمتار على طول محور مشروع وعلى ابعاد متساوية كل منها يساوي ٥٠ متر بقصد عمل قطاع طولي له فكانت: (١,٨ - ٢,٤٠ - ١,٦٠ - ١,٩٠ - ٢,٤٠ - ٢,٠٠ - ١,٣٠ - ٢,٦٠ - ٢,٠٠ - ١,٥٠ - ٢,٧٠ - ٢,٠٠- ١,٥٠) فإذا أخذت القراءة الرابعة والخامسة والقامة مقلوبة، وكانت النقطة الرابعة والسادسة والسابعة دوران والمطلوب:

١. إيجاد مناسيب النقط المختلفة في جدول ميزانية كامل علماً بأن منسوب النقطة الرابعة يساوي ٨ متر.
٢. عمل جميع التحقيقات الحسابية.
٣. رسم القطاع الطولي لمحور المشروع من النقطة الخامسة للنقطة الأخير.

السؤال الرابع (١٥ درجة)

المضلع (أب حـ دأ) فيه طول الضلع (أ ب) =١٠٠ متر والانحراف الجغرافي له = ٢٠ ° وزاوية الاختلاف هى ١٥ ° شرقاً في يناير سنة ١٩٨٠ فإذا كان معدل التغير في زاوية الاختلاف = ١٥ ′ سنوياً شرقاً، ورصدت انحرافات باقي الأضلاع بالبوصلة في يناير سنة ٢٠٢٠ فوجد أن الضلع (ب ج) يتجه شرقاً بطول ١٥٠ متر والضلع (ج د) يتجه نحو الجنوب الغربي بطول ٩٠ متر. فإذا علمت أن إحداثيات نقطة (أ) بالأمتار هي (١٠٠ , ١٠٠) فالمطلوب:

١. إيجاد مركبات جميع أضلاع المضلع.
٢. إيجاد إحداثيات جميع نقط رؤوس المضلع.

انتهت الأسئلة

مع تمنياتنا بالتوفيق والنجاح

First Semester 2021-2022 | 2nd Year Elec. Power Students | Mechanical Engineering (MEP2141)
Final Term Exam (Sunday, 16/01/2022) | No. of Pages: 4 pages | Time allowed is 3 hrs

Notes for Students: **Steam tables are allowed**

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

Question Number (1) (09 Points)

a) **Air Put (√) for the correct sentence and (×) for the wrong sentence.** **(2.5 points)**

1. Fluid mechanics is a division in applied mechanics related to the behaviors of liquids or gases or solid which is either in rest or in motion.
2. Aerodynamics is important to design vehicles, aircraft, missiles, buildings, and wind turbines fluids for which the shearing stress is linearly related to the rate of shearing strain (also referred to as rate of angular deformation) are designated as non-Newtonian fluids.
3. Viscosity of liquids decreases with an increase in temperature, while in gases an increase in temperature causes an increase in viscosity.
4. Pressure transducer converts pressure into an electrical output.
5. Gases in flow condition may consider as incompressible flow if the flow Mach number is less than 0.5.

b) Explain in brief, why some insects do not immerse in liquid and stay on the surface of the fluid. **(2 points)**

c) Explain with drawing the no slip-condition in the fluid. **(2.5 points)**

d) What pressure (bar) is exerted by a liquid of depth ١٠ m upon the base of its container? the local acceleration of gravity is 9.81 m/s^2, the liquid density is ٩٠٠ kg/m^3 and the atmospheric pressure is١٠٠ kPa. **(2 points)**

Question Number (2) (13 Points)

Give a scientific expression for the following statements: Organize your answers by writing the **number of question** and the **Scientific expression** which indicates your answer in a table structured as follow:

Q. No.	Scientific expression	Q. No.	Scientific expression
1		20	
2		21	
3		22	
....		....	

1-	The science of energy which was established to organize the energy conversion process.
2-	A quantity of matter or a region in space chosen for study.
3-	A properly selected region in space. It usually encloses a device that involves mass flow.
4-	A general system of fixed mass where no heat or work may cross the boundaries.
5-	Who recognized the importance of the group (u + Pv) in the analysis of steam turbines and represented it in the tabular and graphical form?

6-	A set of properties that completely describe the condition of the system.
7-	Any change from one state to another.
8-	Engineering flow devices that operate for long periods of time under the same conditions.
9-	A series of connected processes with identical end states.
10-	The internal energy associated with the phase change of a system.
11-	The form of energy that is transferred between two systems as a result of a temperature difference.
12-	The mode of energy transfer between a solid surface and adjacent fluid that is in motion.
13-	A flow passage of varying cross-sectional area in which the velocity of a gas or liquid increases in the direction of flow.
14-	A device in which power is developed as a result of a gas or liquid passing through a set of blades attached to a shaft free to rotate.
15-	A process that can be reversed without leaving any trace on the surroundings.
16-	A substance that has a fixed chemical and homogeneous composition throughout.
17-	The point at which saturated liquid and saturated vapor states are identical.
18-	The ratio of the mass of vapor to the total mass of the mixture.
19-	A process with no change in entropy, is internally reversible and adiabatic.
20-	The product ($\rho.c_p$) and represents the heat storage capability of a material.
21-	Materials that stop or reduce the transfer of heat such as (Styrofoam, wool, and fiberglass).
22-	The transfer of energy from the more energetic particles of a substance to the adjacent less energetic ones as a result of interactions between the particles.
23-	A characteristic of the wall material which is a measure of the ability of a material to conduct heat.
24-	Represents how fast heat diffuses through a material.
25-	It represents the amount of energy needed to vaporize a unit mass of saturated liquid at a given temperature or pressure.
26-	The energy emitted by matter in the form of electromagnetic waves (or photons) as a result of the changes in the electronic configurations.
27-	The idealized surface that emits radiation at the maximum rate.
28-	The property that is a measure of how closely a surface approximates a blackbody.
29-	The law which states that the emissivity and the absorptivity of a surface at a given temperature and wavelength are equal.
30-	The slope of the temperature curve on a T-x diagram.

-31	النسبة بين حجم الإسطوانة الكلى وحجم حيز الخلوص.
-٣٢	تستخدم كمستودع لحفظ الزيت ومنها يسحب الزيت بواسطة مضخات خاصة ويوزع على أجزاء المحرك.
-٣٣	مخزن للطاقة بالنسبة للمحرك حيث تتلقى طاقة الحركة من المحرك المتولدة أثناء شوط التمدد (شوط القدرة) ثم تقوم بإمداد المحرك بالطاقة اللازمة لحركته أثناء الثلاثة أشواط الباقية.
-٣٤	المسافة التى يقطعها المكبس من النقطة الميتة العليا إلى النقطة الميتة السفلى.

٣٥-	جزء من المحرك وظيفته هي تحويل الحركة الترددية للمكبس إلى حركة دورانية.
٣٦-	وظيفتها التحكم فى دخول الشحنة النيه إلى الإسطوانة وخروج العادم منها ويوجد منها نوعان (أحدهما عادة أكبر من الأخر).
٣٧-	يعمل على توصيل الحركة التي يتلقاها من المكبس لتوصيلها إلى عامود المرفق.
٣٨-	هي مؤشرات لمدى نجاح المحرك في إنجاز الوظائف المناطة به، وتستخدم للمقارنة بين المحركات وبعضها.
٣٩-	هي القدرة المتولدة نتيجة ضغط غازات العادم مباشرة على سطح المكبس.
٤٠-	هو الذي يفتح ويغلق الصمامات في الوقت المناسب في أثناء دورة المحرك. و من الممكن أن يوجد في رأس إسطوانة المحرك أو في علبة المرافق.

Question Number (3) (15 Points)

a) A cylinder contains 0.014 m^3 of a fluid at a 7-bar having a specific enthalpy of 695 kJ/kg and a specific volume of 0.00125 m^3/kg. Heat energy is supplied until the volume of the fluid becomes 0.28 m^3 and the pressure remaining at 7 bar. If the final specific internal energy of the fluid is 885 kJ/kg calculate: a) the mass of the fluid. b) the final specific volume, c) the heat energy supplied, d) the work energy transferred. **(7 points)**

b) A piston–cylinder device contains 25 g of saturated water vapor that is maintained at a constant pressure of 300 kPa. A resistance heater within the cylinder is turned on and passes a current of 0.2 A for 5 min from a 120-V source. At the same time, a heat loss of 3.7 kJ occurs. (*a*) **Show** that for a closed system the boundary work W_b and the change in internal energy ΔU in the first-law relation can be combined into one term, ΔH, for a constant pressure process. (*b*) **Determine** the final temperature of the steam. **(8 points)**

Question Number (3) (16 Points)

a) The power output of an adiabatic steam turbine is 5 MW, and the inlet and the exit conditions of the steam are as indicated in Fig. (1). (a) **Compare** the magnitudes of Δh, Δke, and Δpe. (b) **Determine** the work done per unit mass of the steam flowing through the turbine. (c) **Calculate** the mass flow rate of the steam. **(8 points)**

b) 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. **(8 points)**

Case	T, (°C)	P, (kPa)	v, (m^3/kg)	h, (kJ/kg)	Phase description and quality (if applicable)
1	.....	500	.....	3293	.....
2	.....	300	0.5	.....	.....
3	30	200	.....	.....	.....
4	140	.....	.....	2400	.....

Question Number (4) (20 Points)

a) A transistor with a height of 0.4 cm and a diameter of 0.6 cm is mounted on a circuit board. The transistor is cooled by air flowing over it with an average heat transfer coefficient of 30 W/m^2·K. If the air temperature is 55°C and the transistor case temperature is not to exceed 70°C, determine the amount of power this transistor can dissipate safely. Disregard any heat transfer from the transistor base. See Fig. (2) **(4 point)**

b) A steam pipe of inner and outer diameters 1.6 and 1.7 cm respectively is covered with two layers of insulation. The thickness of the first layer is 3 cm and that of the second layer is 5 cm. the thermal conductivities of the pipe and insulating layers are 58, 0.174 and 0.093 W/m.K, respectively . The temperature of the steam is 400 °C, and that of the outer surface of the insulation layer is 50 °C and convection heat transfer coefficient between the steam and inner surface of the pipe is 150 W/m^2·K. Determine the heat loss per meter and the pipe inner surface temperature. **(7 points)**

c) An air standard Diesel cycle with a compression ratio of 15. The pressure and temperature at the beginning of compression are 1 bar and 27 °C. The heat supplied at a constant pressure is 2850 kJ/kg of air. **Draw** the cycle on (P-v) and (T-s) diagrams, then **determine** the following: (a) The cut-off ratio of the cycle. (b) The work ratio of the cycle. And (c) The thermal efficiency of the cycle. **(8 points)**

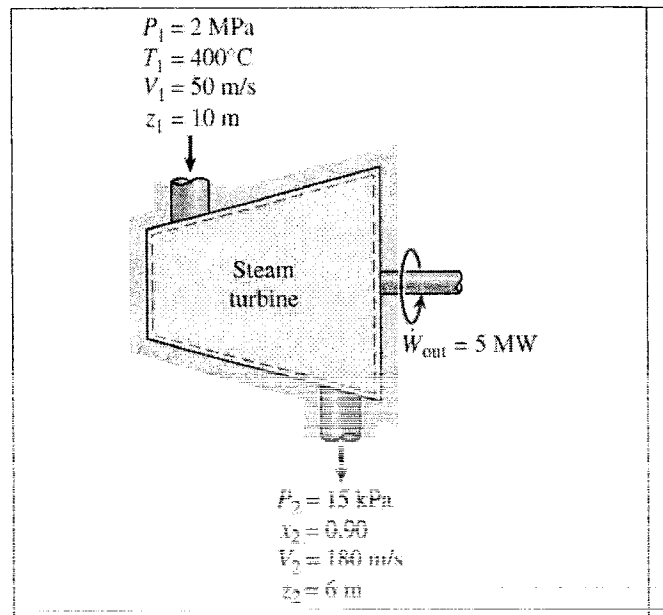


Fig. 1 - Problem No.3 (a)

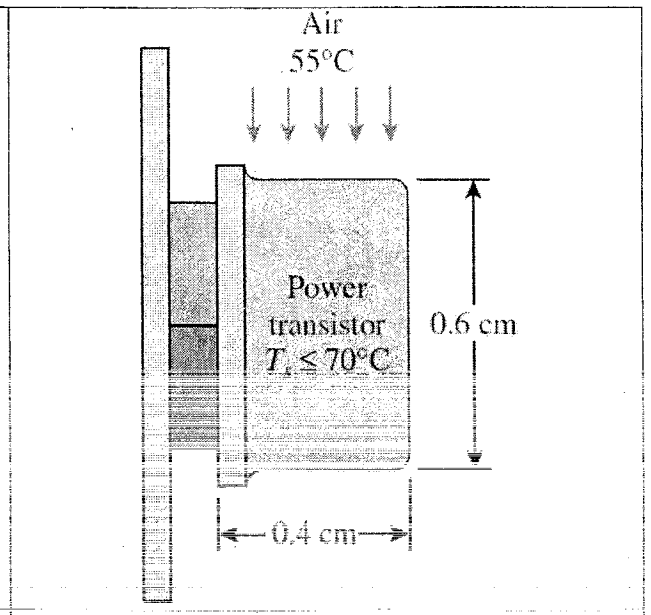


Fig. 2 - Problem No.4 (a)

TANTA UNIVERSITY

Electrical Power and Machines Engineering Department

Faculty of Engineering

Final EXAM 2021/2022 - First Term

Course	Energy Conversion (EPM2106)	Time Allowed	3 hours
Students	2nd Year (Electrical Power and Machines)	Total Mark	90
Date	23 / 01 / 2022	Number of pages	FOUR

قبل أن تبدأ إجابتك الرجاء قراءة التعليمات العامة الآتية والالتزام بها بكل دقة:

١. اكتب رقم السؤال بوضوح.	٢. استخدم الرسومات التوضيحية ذات البيانات الواضحة والكاملة كلما أمكن.
٣. أجب بوضوح سواء باللغة الإنجليزية أو العربية.	٤. لا يشترط الإجابة بترتيب الأسئلة في ورقة الامتحان.
٥. افترض قيمًا معقولة لأية بيانات ناقصة.	٦. فيما عدا الرسومات لا تستخدم القلم الرصاص إلا في أضيق الحدود
٧. ابدأ إجابة كل السؤال في بداية صفحة جديدة	٨. تجنب تمامًا في إجاباتك استخدام: • اللونين الأحمر والأخضر • سائل التصحيح corrector
٩. يُخصص حوالي ٢٠% من تقييم درجة كل لسؤال على جودة تنظيم الإجابة ودقة الرسم	

Answer ALL the following Six questions and problems:

The First Question (13 marks)

1. With the aid of BH curve of a permanent magnet material **Drive** the effect of air gap length on the position of the operation point.

2. Two coils with a coefficient of coupling of 0.5 between them, are connected in series so as to magnetize (a) in the same direction (b) in the opposite direction. The corresponding values of total inductances are for (a) 1.9 H and for (b) 0.7 H. **Find** the self-inductances of the two coils and the mutual inductance between them.

3. A 1φ, 120 V, 60 Hz supply is connected to the coil of Fig. 1. The coil has 200 turns. The parameters of the core are as follows: Length of core = 100 cm, Cross-section area of core = 20 cm^2, Relative permeability of core = 2500.
   (a) **Obtain** an expression for the flux density in the core.
   (b) **Obtain** an expression for the current in the coil.

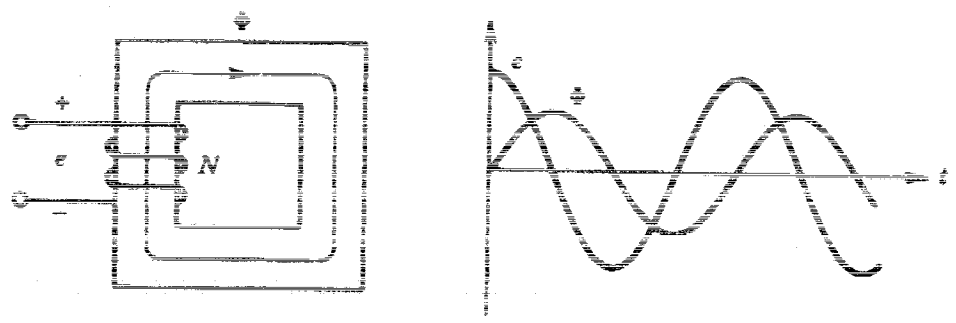


Fig. 1

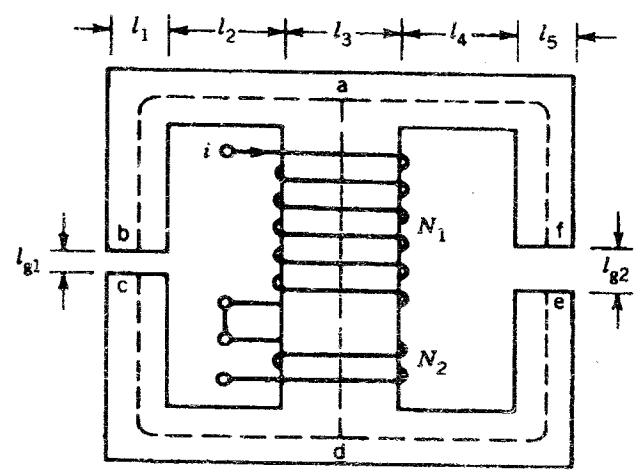
The Second Question (17 marks)

1. **Find** the total energy stored in two magnetically coupled coils? Assume the magnetic circuit is linear.

2. **Find** the relation of the voltage ratio in two magnetically coupled coils? Assume the magnetic circuit is linear

3. A square wave voltage of amplitude E =100 V and frequency 60 Hz is applied on a coil wound on a closed iron core. The coil has 500 turns, and the cross-section area of the core is 0.001 m^2. Assume that the coil has no resistance. **Find**
   (a) The maximum value of the flux and **sketch** the waveforms of voltage and flux as a function of time.
   (b) The maximum value of E if the maximum flux density is not to exceed 1.2 Tesla.

4. The magnetic circuit of Fig. 2 provides flux in the two air gaps. The coils (N_1=700, N_2=200) are connected in series and carry a current of 0.5 Ampere. Neglect leakage flux, reluctance of the iron, and fringing at the air gaps.
   Determine the flux and flux density in the air gaps.



l_{g1} = 0.05 cm, l_{g2} = 0.1 cm
$l_1 = l_2 = l_4 = l_5$ = 2.5 cm
l_3 = 5 cm
depth of core = 2.5 cm

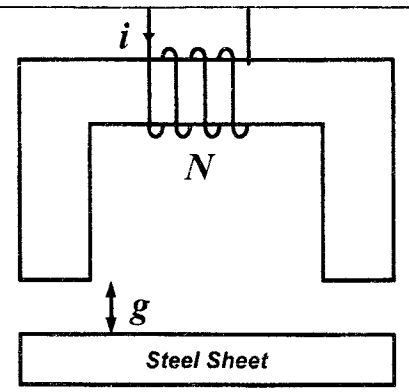
The Third Question (18 marks)

1. Sketch the space variation of self and mutual inductances of the following *four-pole* single phase machines: **(5 marks)**
   a) Cylindrical rotor synchronous machine
   b) Synchronous reluctance machine

2. For a *translational linear* system, with the aids of current-flux linkage curves show the following amounts (*Use a separate sketch for each case*). **(5 marks)**
   a) Stored energy for a certain **fixed position**.
   b) Electrical energy supplied to **a fixed system** when the current increases from I_1 to I_2
   c) Electrical energy supplied when the system moves **very slowly** from position "a" to position "b" while the current increases from I_a to I_b.
   d) Electrical energy supplied when the system moves from position "a" to position "b" **while the system** is supplied from fixed dc source. The motion **speed is moderate** (neither slow nor fast)
   e) Energy converted into mechanical form when the system moves **very slowly** from position "a" to position "b" while it is supplied from a fixed dc source

The Third Question (continued)

3. The lifting magnetic system shown in figure has a square cross-section of 5x5 cm². The coil has N= 400 turns and a resistance of 5 Ω. The magnet is used to lift a steel sheet. The reluctance of magnetic parts and field fringing in the two air-gaps are negligible. When the air-gap length g=1 mm, an average force of 550 N is required to lift the steel sheet:



a) For a dc supply, determine:
   i) The source voltage.
   ii) The stored energy in the magnetic field.

b) For an ac supply of 50 Hz, determine the source voltage. **(8 marks)**

The Fourth Question (13 marks)

1. For a singly-excited *rotating* electromechanical energy converter: **(5 marks)**
   a) Derive relations for the developed torque in terms of co-energy.
   b) Show how to determine direction of motion.

2. A two-pole rotating machine has a stator and rotor self-inductances of 0.15 and 0.06 H respectively. The mutual inductance between stator and rotor windings has a maximum value of 0.08 H. The rotor is driven at 3000 rpm.
   a) The stator carries an ac current of 5 A (rms) and a frequency of 50 Hz, while the rotor winding is open. Determine *instantaneous*, *rms* and *frequency* of induced voltage across rotor windings.
   b) If stator and rotor windings are connected in series, and supplied by 5 A (rms) at 50 Hz, determine:
      i) Speeds at which nonzero average torque can be produced.
      ii) Maximum torque that the machine can produce at each speed obtained in part i)

(8 marks)

The Fifth Question (19 marks)

1. For a rotating doubly-excited electromechanical energy conversion device of **cylindrical stator** and **rotor**. **(5 marks)**
   a) Derive a general expression for the electromagnetic torque acting on the rotor.
   b) Show all the possible conditions of providing non-zero average torque.

2. Show that a single-phase concentrated winding excited from an AC supply: **(5 marks)**
   a) produces an mmf of a fundamental space distributed wave.
   b) This wave is of pulsating nature.
   c) It can be viewed as the resultant of two mmfs rotating in opposite directions.

3. What are the motivations of distributing and chording electrical machine windings?
   (answer briefly with simple illustrations!) **(4 marks)**

4. Explain what is meant by *specific electric loading* and *specific magnetic loading*.
   Then, show with suitable relations how they *affect the main dimensions* of an electrical machine. **(5 marks)**

Please Turn Over

The Sixth Question (12 marks)

1. Using suitable clarifications of sufficient data, show the following: **(4 marks)**
   a) Solar cell characteristics.
   b) A wind-energy-based generating system.

2. A farm needs 4 pumps for irrigation, each of which is powered by a 10 hp, 225 V DC motor of efficiency 85%. Design the solar power station necessary for the farm operation. The available solar modules has a rating of 25.9 V and 7.03 A. **(5 marks)**

3. A wind turbine with three blades has a rotor of diameter 100 m and a power coefficient of 0.4. The wind speed is 9 m/s and air density is 1.23 kg/m³. Calculate the captured power. **(3 marks)**

Good Luck and best wishes

Prof. Essam Eddin M. Rashad and Dr. Mahmoud F. Elmorshedy