



1. a- Use neat sketches to illustrate the construction of a 6-pole, rotating field, salient type synchronous machine rotor. (5 marks)
  - b- A 3-phase, 4-pole, has 36-slot, the winding is chorded by one slot and has two parallel paths. Find the distribution and pitch factors for the machine. (5 marks)
  - c- The machine in (b-) has 10 conductors per slot and is driven at 1500 rpm to generate phase voltage of 220V, Find the frequency of the induced voltage, and the flux per pole. (5 marks)
  - d- The generator above has an armature resistance of 0.5 ohm and synchronous reactance of 1.5 ohm. If it supplies a load of 10A find the terminal phase voltage and the load angle when the load power factor is 0.8 lagging, unity and 0.8 leading (9 marks)
  - e- Calculate the voltage regulation in case of unity power factor (2 marks)
  2. a- What are the requirements that must be satisfied to connect a 3-phase alternator to an infinite bus bar? (4 marks)
  - b- Two alternators are connected in parallel to supply a load of 1MVA at 0.7 lagging power factor. The two generating units have the following linear external characteristics.
- |                 | Unit A  |     | Unit B  |     |
|-----------------|---------|-----|---------|-----|
| Power in KW     | No load | 400 | No load | 600 |
| Frequency in Hz | 52      | 48  | 51      | 48  |
- Find the operating frequency and the power delivered by each generator (15 marks)
3. a- State the different methods used for starting poly-phase induction motor (5 marks)
  - b- State the different methods used to control the speed of poly-phase induction motor (5 marks)
  - c- How can you change the direction of rotation of a poly-phase induction motor (5 marks)
  - d- Can induction motor produce torque at its synchronous speed? Explain. (5 marks)
  - e- Sketch a typical torque speed characteristic for a poly-phase IM showing the breakdown, no-load speed, and starting torque operating points. (5 marks)
  - f- Compare between type A and type C induction motors according to NEMA classification. Explain what does NEMA stand for. (5 marks)
  4. A three phase, four poles, 380V, 50Hz, Y connected induction motor has the following parameters:  $r_1=1\Omega$   $r_2'=1.2\Omega$   $x_1=1.5\Omega$   $x_2'=1.5\Omega$   $R_c=880\Omega$   $x_m=440\Omega$ , mechanical losses 66 W. if the motor runs at 1410 rpm, find: (15 marks)
    - i – Synchronous speed
    - ii – slip
    - iii – core losses power
    - iv - Stator copper losses
    - v – air gap power
    - vi – rotor copper losses
    - vii - developed power
    - viii - input current
    - ix - input power
    - x - output power
    - xi – efficiency
    - xii – developed torque
    - xiii – output torque
    - xiv - power factor
    - xv - draw the power flow diagram

Use these constants if needed:

$$1 \text{ eV} = 1.6022 \times 10^{-19} \text{ J}$$

$$m_p = 1.673 \times 10^{-27} \text{ kg}$$

$$h = 4.1357 \times 10^{-15} \text{ eV}\cdot\text{s}$$

$$\hbar = 1.055 \times 10^{-34} \text{ J}\cdot\text{s}$$

$$m_e = 9.109 \times 10^{-31} \text{ kg}$$

$$R = 1.097 \times 10^7 \text{ m}^{-1}$$

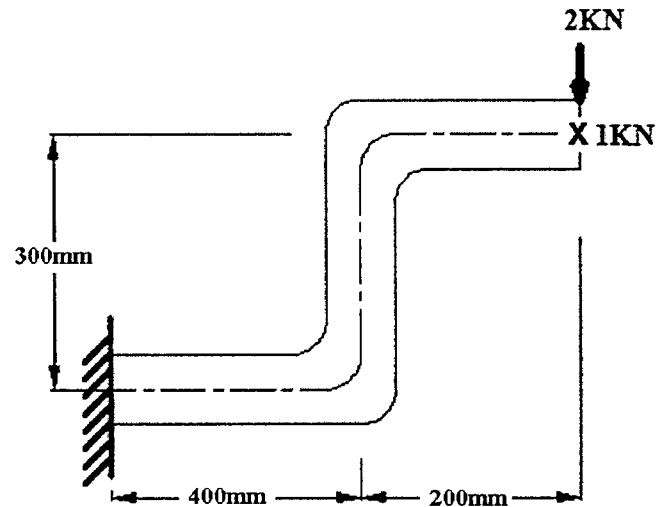
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- 1) i. Deduce the formula giving the radioactive decay law  
 ii. Compare between natural radioactivity and artificial radioactivity  
 iii. In an accident with a nuclear reactor,  $\text{Te}^{131}$  a radioactive fission product of uranium escapes to the atmosphere. When will the activity of the daughter product  $\text{I}^{131}$  reach its maximum value and what is the iodine activity in terms of the initial activity of the escaping  $\text{Te}^{131}$ .  
 Half lives of  $\text{Te}^{131}$ ,  $\text{I}^{131}$  are 1.25 and 8.0 days respectively.
  
  - 2) i. Deduce the binding energy formula derived on the basis of the liquid drop model.  
 ii. From the semi empirical mass formula derive a condition for the most stable nucleus  $Z_0$  at a given mass number A. Plot A- $Z_0$  against  $Z_0$ . Comment
  
  - 3) i. What are the experimental results which led to the hypothesis that nuclei have discrete energy levels. How is this hypothesis proved?  
 ii. The nuclide  $\text{Rn}^{211}$  emits three groups of alpha particles with kinetic energies of 5.847 and 5.613 MeV. Associated with the alpha particles are gamma rays with energies of 0.0687, 0.169 and 0.238 MeV. Construct a decay scheme based on these data.
  
  - 4) Three conservation principles are all apparently violated during beta-decay process. Discuss the explanation given by Fermi and show how it is proved experimentally.
  
  - 5) i. Discuss the following characteristics of the passage of charged particles through media: Straggling- Range – Specific ionization- Stopping power  
 ii. Discuss the different types of the interaction of gamma-rays with matter.
  
  - 6) i. A heterogeneous beam of gamma rays from a radioactive source is allowed to fall on an aluminum foil and the electrons ejected are analyzed in a magnetic spectrograph. The electrons fall into two groups with maxima at  $1.2 \times 10^{-2}$ ,  $0.6 \times 10^{-2}$  tesla.metre. What are the energies of the two gamma photons  
 ii. Derive an expression for the kinetic energy in ev with which the nucleus recoils, when a gamma-photon is emitted, express the energy of the gamma-photon in KeV, and mass of the recoil nucleus in amu



**Answer the following questions:**

**Question one: (16 marks)**

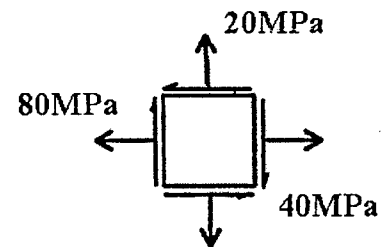
The round bar shown in the figure has a uniform diameter of 50 mm. Determine the maximum shear stress.



**Question two : (16 points)**

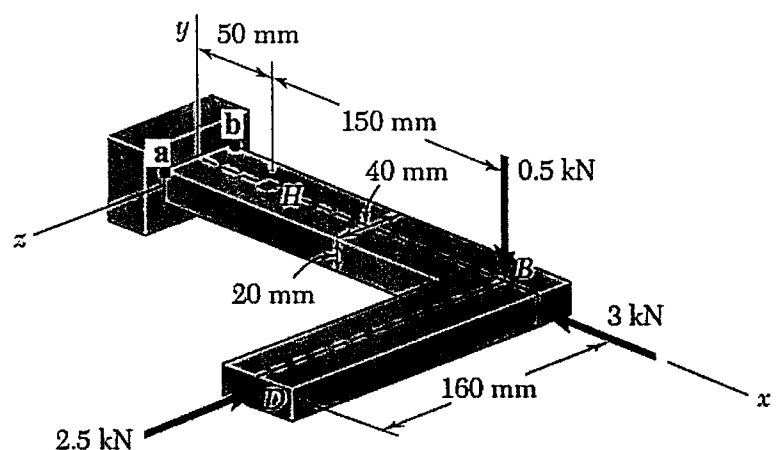
For the state of stress shown in figure using Mohr's circle and formulas:

- The Principal Planes.
- The Principal Stresses.
- The Maximum shear stress and the corresponding normal stress.



**Question three: (17 marks)**

Three forces are applied to the machine component ABD as shown. Determine the maximum normal stress at points (a) and (b).



**Question four: (15 points)**

A steel cylinder of 50 mm inner diameter, 10 mm wall thickness, and its allowable normal stress is 120 MPa. Find the maximum internal pressure that can be applied in this cylinder.

If it is required to decrease the maximum stress by 20% by shrinking another steel cylinder with 100 mm outer diameter, determine the maximum radial interference. ( $E=200\text{GPa}$ )

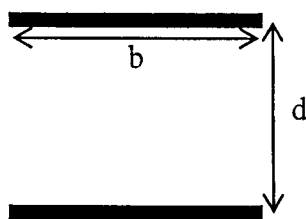
**Question five: (13 points)**

The cover of a pressure vessel is held in place by ten M16 bolts. The pressure inside the vessel is 1.5 MPa, and the effective area of the cover is  $0.2\text{ m}^2$ . The ratio of the stiffness of the bolt to that of the connected parts is 0.5. Each bolt is initially tightened to 18 kN, and has a tensile-stress area of  $157\text{ mm}^2$ . The bolt has a proof strength of 180 MPa, and yield strength of 200 MPa.

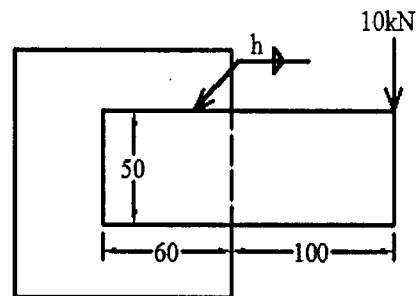
- i. Will the joint separate under load?
- ii. Are the bolt stresses OK?

**Question six: (13 points)**

For the shown figure, find the required weld size  $h$  if the allowable shear stress for the weld is 100 MPa. Given that the unit moment of inertia & unit polar moment of inertia are as follows (respectively):  $I = 0.5 b d^3$  &  $J = 1/6 d (3b^2 + d^2)$ .



Weld shape



Welded configuration



Course title Number:  
Nuclear Fuel Cycles  
4<sup>th</sup> Year  
Time allowed: 3 hrs

اسم المقرر والرقم الكودي له:  
دورات الوقود النووي  
السنة الدراسية: الرابعة  
الزمن : ثلاث ساعات

**Answer All Questions:**

1-a. What is meant by "the nuclear fuel cycle"? Mention and sketch the options showing the main steps in each case.

b. what is the function of each of the following nuclear fuel cycle steps: concentration – purification – conversion – enrichment.

c. Describe briefly, using a flow chart, the steps in conventional uranium refining and conversion starting with the uranium ore concentrate and ending with pure  $UF_6$ .

Q2-a. What are, in general, the requirements that an organic solvent suitable for separation of metals by fractional extraction should meet?

b. "TBP meets most the conditions required for a solvent suitable for fractional extraction of metals, except those of ....., and....." What are the two missing conditions? Show how these deficiencies are overcome.

c- Should the value of solvent extraction distribution coefficient be always high? Explain your answer.

d-Show using a flow sheet the fractional extraction of uranium and plutonium from spent fuel.

Q3-c. Describe how ion exchange is used to extract uranium from the acid leach solution.

b- Describe with the help of a flow chart and appropriate chemical equations the recovery of uranium from acid leach liquor using solvent extraction

c. Compare between Ca and Mg as reductants for  $UF_4$  to produce U metal.

Q4. a. Starting with  $UF_6$ , describe the steps to get  $UO_2$  pellets.

b. Few years ago, the uranium yearly uranium production was less than the requirements. Write a short note about uranium requirements and resources in the world showing how the requirements were fulfilled in such cases.

Q5- a. Define the following terms used in the field of uranium enrichment:

cascade - stage separation factor -- separative work unit

b. Describe with the help of simple drawings the principles of uranium enrichment by gas diffusion and by gas centrifuge methods. Compare between the two methods.

c. If the 1000 MW(e) PWR needs every year about 25 tons of fresh uranium, in the form  $UO_2$ , enriched to 3.5%, calculate the yearly requirements of enrichment separative capacity and natural  $U_3O_8$ . The tails assay is 0.3%.

Also calculate the number of enrichment stages needed if the enrichment facility uses:

(i) gaseous diffusion units (ii) gas centrifuge units

Assume reasonable values for the stage separation factor in each case.

d. Compare between the maximum allowable rotational speed of a centrifuge bowl, 0.2 m in diameter, if it is made of:

(i) aluminium alloy (tensile strength =  $5200 \text{ kg/cm}^2$  and density =  $2.8 \text{ g/cm}^3$ )

(ii) glass fibre (tensile strength =  $7000 \text{ kg/cm}^2$  and density =  $1.9 \text{ g/cm}^3$ )

Exam Committee: Lecturer Name, Prof. M. Ghoneim





Answer the following questions

**Question (1): (14 marks)**

(a) Use the method of separation of variables to find product form eigen-functions (solutions) of the

following eigen-value problem:  $\frac{\partial u}{\partial x} - 2 \frac{\partial u}{\partial t} = u$

(b) Find the general solution of the following partial differential equations:

(i)  $(D_x^2 + 3 D_x D_y + D_y^2) z = e^{x+y}$

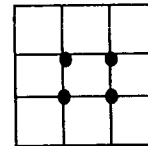
(ii)  $(D_x^3 - 7 D_x D_y^2 - 6 D_y^3) z = \sin(x + 2 y)$

**Question (2): (15 marks)**

(a) Given the Poisson equation

$$\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + (x^2 + y^2 + 10) = 0$$

satisfying that  $u = 0$  over the square boundary  $x = y = 0$  and  $x = y = 3$ . Divide the square into nine equal parts (see figure below) and obtain the values of  $u$  at the four interior points using centered-difference approximations of the partial derivatives.



(b) Prove that  $F\{v_t(x,t)\} = (i\omega) V(x,\omega)$  and hence use Fourier transform to solve:

$$\frac{\partial^2 v}{\partial t^2} = \frac{\partial^2 v}{\partial x^2}, \quad -\infty < t < \infty, \quad x > 0$$

subject to: (i)  $v(0,t) = e^{-2|t|}$  (ii)  $v_x(0,t) = 0$

**Question (3): (16 marks)**

(a) Using the method of separation of variables, find the temperature  $u(x,t)$  in a bar of length 10cm which is perfectly insulated laterally and whose ends are kept at temperature  $0^\circ\text{C}$  ( $u(0,t) = u(10,t) = 0$ ) and whose initial temperature is given by

$$u(x,0) = \begin{cases} x, & 0 < x < 5 \\ 10 - x, & 5 < x < 10 \end{cases}$$

(Hint: The 1-D heat equation is given by:  $\frac{\partial u}{\partial t} = c^2 \frac{\partial^2 u}{\partial x^2}$ )

(b) Re-work part (a) using Explicit Forward-in-Time-Central-in-Space finite difference algorithm to find the temperature distribution at time  $t = 0.2$ . Set  $\Delta x = 2.5 \text{ cm}$ ,  $\Delta t = 0.1$  and  $c = 1$ .

Question (4)

(a) Find the values of  $z$  which satisfy the following equations:

$$(i) e^{4z} = 1 - i\sqrt{3} \quad (ii) \sin z = 2i$$

(b) Evaluate: (i)  $(1-i)^i$  (ii)  $\ln\left(\frac{1+i}{1-i}\right)$

(c) Show that:  $|\cos z|^2 = \cos^2 x + \sinh^2 y$ .

Question (5)

(a) Show that  $U(x,y) = 2xy - e^x \sin y$  is a harmonic function. Find the conjugate harmonic function  $V(x,y)$  and  $F(z) = U + iV$  in terms of  $z$ . Evaluate  $F'(z)$  at  $z = i\pi/2$ .

(b) Evaluate the following integrals:

$$(i) \int_0^i e^z dz \quad (ii) \int_0^{\pi i} z \cos z dz$$

Question (6)

(a) Evaluate the following contour integrals:

$$(i) \oint_C \frac{2 dz}{z(z-1)^2} \quad \text{where } C \text{ is } |z-1|=2 \quad (ii) \oint_C \frac{e^{z^2} + 3 \cosh z}{3z^2 - 7z + 2} dz \quad \text{where } C \text{ is } |z+1|=1$$

$$(iii) \oint_C \frac{dz}{z^3(z^2+4)} \quad \text{where } C \text{ is the unit circle}.$$

(b) Using contour integration evaluate the following integrals:

$$(i) \int_0^{2\pi} \frac{\sin \theta}{5-3\cos \theta} d\theta \quad (ii) \int_{-\infty}^{\infty} \frac{2x^2-1}{x^4+10x^2+9} dx$$

66/3



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لوائح وتشريعات  
السنة الثانية  
الزمن : ساعتان  
٢٠١٤-٢٠١٥

اجب عن الاسئلة الاتية :

١- ا) اذكر انواع التراخيص اللازمة للمراحل المختلفة للمحطة النووية. وما اسم الجهة التي تقوم باصدارها ؟

ب) كيف تضع خطة طوارئ اشعاعية لمعمل يحتوى علي مصدر اشعاعي ؟  
ج) يراد نقل شحنة وقود محترق من محطة نووية الى دولة متخصصة في معالجة الوقود.  
تکلم عن الاجراءات التنظيمية والفنية لنقل الشحنة بامان . ( ٧ درجات )

٢- ا) ماهي مهام الهيئة الرقابية علي الانشطة النووية والاشعاعية ؟  
ب) ما هي الانشطة والمنشآت التي تستلزم لوائح وتشريعات رقابية ؟  
ج) فيم يستخدم : الثوريوم - الكوبلت المشع - اليورانيوم المنضب . ( ٧ درجات )  
٣- ا) ماهي الاجراءات والمستلزمات لاقامة محطة نووية في الضبعة ؟

ب) تكلم عن دور الوكالة الدولية للطاقة الذرية للتحقق من امان المواد ، والمنشآت النووية  
ج) كيف نقل من الخطاء البشري في المحطات النووية ؟ ( ٧ درجات )

٤- ا) عرف : القانون النووى - المادة النووية - الجهة المشغلة  
ب) في مصر أنشطة ، ومنشآت نووية واشعاعية، وهيئات نووية تكلم عن ذلك. ( ٧ درجات )  
٥- ا) تم تكليف مسئول نقل مواد مشعة بنقل مصدر من اليود المشع من القاهرة الي مستشفى في اسبوت . اخذ هذا المسئول المصدر ووضعه في علبة من الكرتون ، وركب ميكروباس.  
اذكر الاخطاء التي ارتكبت ، والمخاطر المحتملة اثناء عملية النقل والتداول. وماهي مقترحاتك.  
ب) تكلم عن كيفية تامين مخزن يحتوى علي مواد مشعة . ( ٧ درجات )

مع تمنياتى بالتوفيق . ا.د. محمد كمال شعت

1. a) sketch the load characteristic of shunt motor and explain why the load voltage falls when the load current increased.  
b) Explain why a D.C. Motor need a starter.  
c) shunt d.c. M/c connected to 250V supply, has an armature resistance of  $0.12 \Omega$  and field resistance of  $100 \Omega$ , find the ratio of the speed as a generator to the speed as a motor with line current in each case 80 A.
2. a) How may the speed of a d.c. shunt motor be controlled?  
b) A d.c. motor takes an armature current of 110 A at 480 V. The resistance of armature circuit is  $0.2 \Omega$ . The M/c has 6 poles the armature is lap connected with 864 conductors. The flux per pole is 0.05 weber. find i) the speed ii) the torque of motor.
3. a) Explain why the e.m.f. of d.c. generator depends on the speed during the saturation period.  
b) 4 pole armature is wound with 564 conductors lap connected d.c. generator driven at 800 r.p.m. The flux per pole is 20 mWb. The current in each conductor is 60 A. calculate the total current, the e.m.f. and the power generated by the armature.

4. a) Draw the torque-slip curve for a 3-phase induction Motor and explain the factors which determine the shape of this curve
- b) 3-phase induction motor, 400V, 50A and P.f. = 0.86 at full load with slip of 0.04  
when running at no-load at 400V the iron losses is 1350W and the friction losses 650W  
The resistance per phase of the stator winding (delta winding) is 0.5Ω  
Find the efficiency and % power of motor
5. a) Draw the Vector diagram of synchronous Generator with all possible power factor
- b) Draw the Vector diagram of synchronous Motor with all possible power factor
- c) Single phase synchronous Generator having syn. reactance  $X_s = 5.5 \Omega$  and armature resistance 0.6Ω, delivers a current of 100amp.  
Calculate the voltage regulation of generator if the terminal voltage is 2000V and p.f. 0.8 lag.  
Sketch with scale the vector diagram

P.D. Tarek Afifi