THE UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING (UNDERGADUATE)

2015/2016 EXAMINATION PAPER

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THE UNIVERSITY OF ZAMBIA

School of Engineering

Department of Civil & Environmental Engineering

CEE 2219-Statics and Introduction to Mechanics of Materials

Academic Year 2015/2016

FINAL EXAM

September 2015 **Time allowed: Three hours**

CLOSED BOOK Examination

Instructions to candidates:

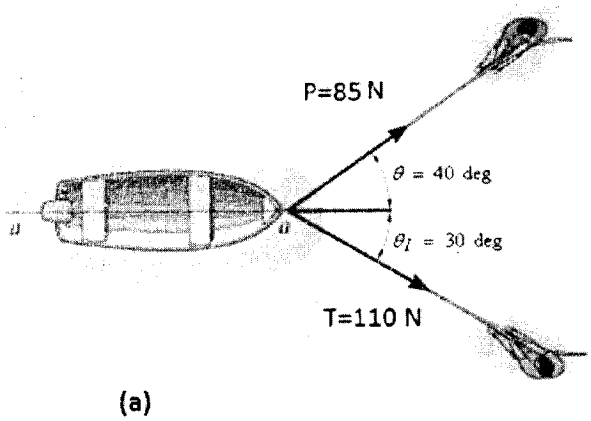
1. **Candidates must ensure that their computer numbers are clearly written on each answer sheet**
2. **Answer any FIVE questions. All questions carry equal marks (20%)**

Question 1

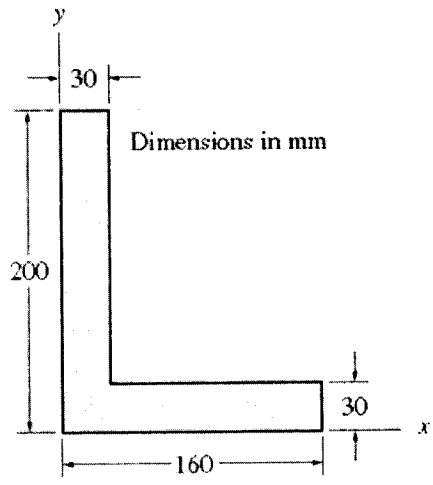
a) The boat shown in Figure1.0:Q1(a) is being pulled onto the shore using two ropes. Determine the magnitude and direction of the resultant force.

[10 marks]

b) Determine the second area moment about the *x-axis* for the cross-section shown in Figure 1:Q1(b). **[10 marks]**



(a)



(b)

Figure 1:Q1

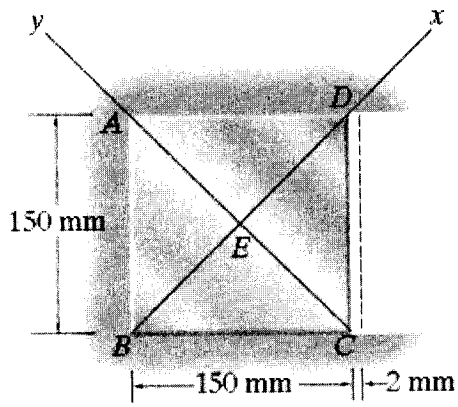
Question 2

a) The plate shown in Figure 2:Q2(a) is fixed connected along AB and held in the horizontal guides at its top and bottom, AD and BC. If it's right side CD is given a uniform horizontal displacement of 2 mm, determine the shear strain at E relative to the x, y axes.

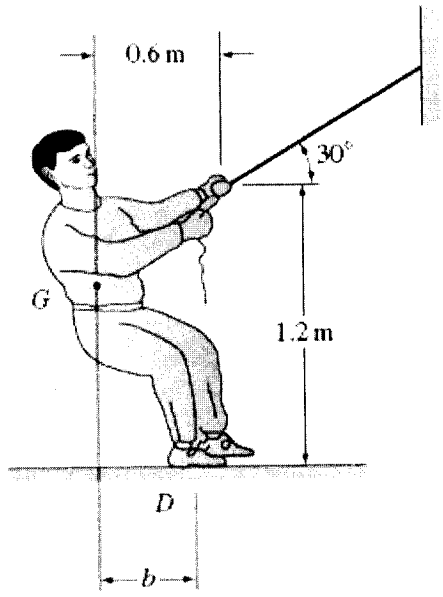
[10 marks]

b) The center of gravity of the 850-N man is at G (Figure 2:Q2(b)). If the man pulls on the rope with a 388-N force, determine the horizontal distance b between the man's feet and G.

[10marks]



(a)



(b)

Figure 2:Q2

Question 3

The beam ABC shown in Figure 3.0:Q3 is subjected to a uniform distributed load. The supports at A, C and B are pinned.

a) Determine the magnitude the reaction force at supports B and the vertical reaction at support A.

[10 marks]

b) Draw the shear force diagram for the beam ABC

[10 marks]

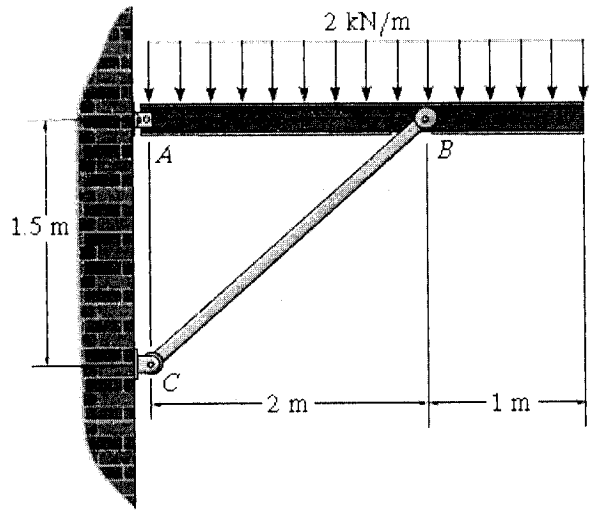


Figure 3:Q3

Question 4

The square steel plate has a thickness of 10 mm and is subjected to the edge loading shown in Figure 4.0:Q4.

a) Determine the maximum shear stress in the plane of the plate. Use clearly labeled stress elements in your solution.

[8 marks]

b) Determine the stress components on the inclined plane *AB* given θ=20°. Use clearly labeled stress elements in your solution.

[12 marks]

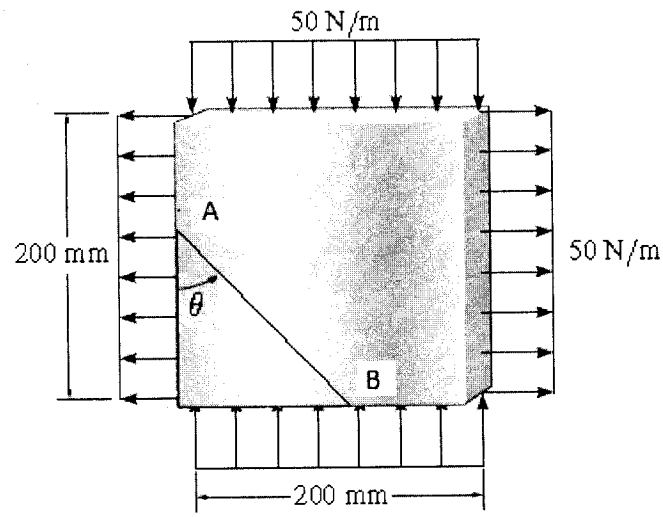


Figure 4:Q4

Question 5

A *3000 kg* front-wheel-drive truck (SUV) has a center of mass at *G* (see Figure 5: Q5). Determine the maximum mass of the log that can be towed by the truck. The coefficient of static friction between the log and the ground is $\mu_s = 0.8$, and the coefficient of static friction between the front wheels of the truck and the ground is $\mu'_s = 0.4$ .The rear wheels are free to roll. Assume that the engine of the truck is powerful enough to generate a torque that will cause the front wheels to slip.

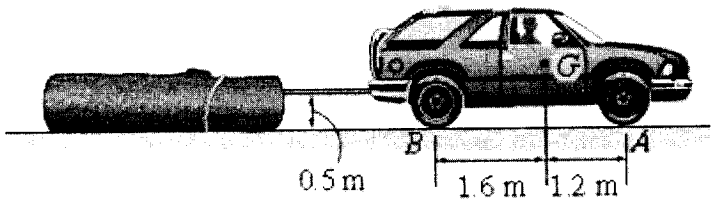


Figure 5:Q5

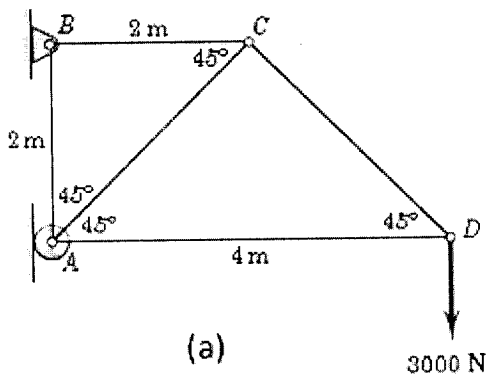
[20 marks]

Question 6

a) Determine the magnitude and direction of the force in member *BC* of the loaded truss shown in Figure 6.0:Q6 (a).

[5 marks]

b) If the wood joint in Figure 6.0:Q6 (b) has a thickness of 150 mm, determine the average shear stress developed along shear planes *a–a* and *b–b*. For each plane, represent the state of stress on an element of the material. **[15 marks]**



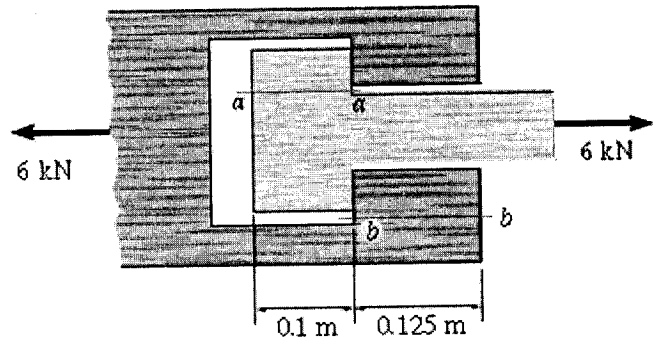


Figure 6:Q6

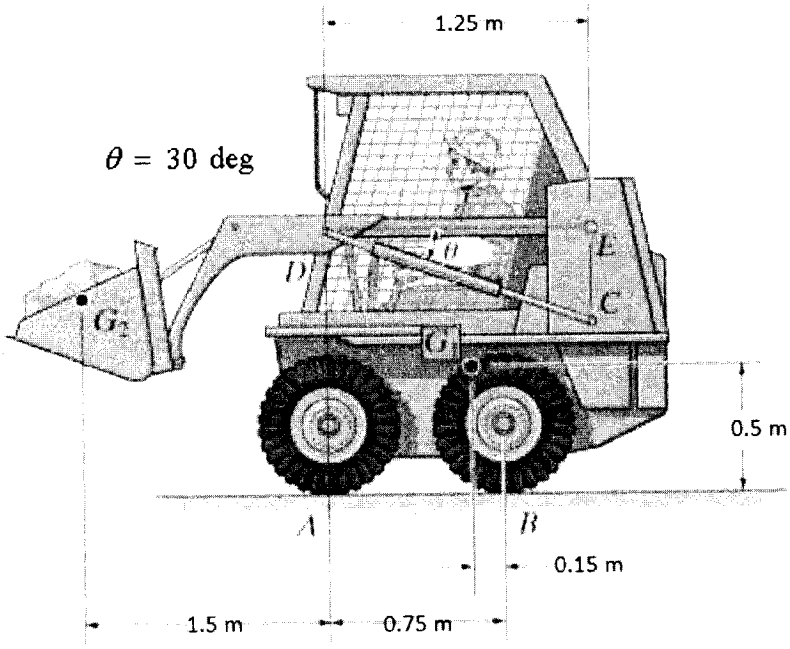
Question 7

a) The skid steer loader shown in Figure 7:Q7 (a) has a mass *1180 kg*, and in the position shown the center of mass is at G_1. If there is a stone of mass *300 kg* in the bucket, with center of mass at G_2 determine the force in the hydraulic cylinder *CD*. There is a similar linkage on each side of the loader.

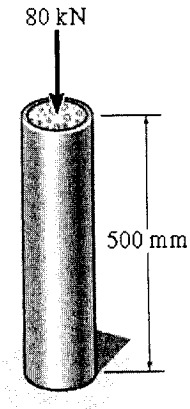
[8 marks]

b) The steel pipe shown in Figure 7:Q7 (b) is filled with concrete and subjected to a compressive force of *80 kN*. Determine the average normal stress in the concrete due to this loading. The pipe has an outer diameter of *80 mm* and an inner diameter of *70 mm*. *Est = 200 GPa, Ec = 24 GPa.*

[12 marks]



(a)



(b)

Figure 7:Q7

THE END

Second Area Moments Equations

Rectangular Area Second Area moment

$$\bar{I}_x = \frac{1}{12} bh^3$$
$$\bar{I}_y = \frac{1}{12} b^3 h$$

Second area Transformation Equations

$$I = \bar{I} + Ad^2$$
$$I_{x'} = \frac{I_x + I_y}{2} + \frac{I_x - I_y}{2} \cos 2\theta - I_{xy} \sin 2\theta$$
$$I_{y'} = \frac{I_x + I_y}{2} - \frac{I_x - I_y}{2} \cos 2\theta + I_{xy} \sin 2\theta$$
$$I_{x'y'} = \frac{I_x - I_y}{2} \sin 2\theta + I_{xy} \cos 2\theta$$

Stress Transformations

$$tan2\theta_p = \frac{\tau_{xy}}{(\sigma_x - \sigma_y)/2}$$

$$\sigma_{1,2} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + {\tau_{xy}}^2}$$

$$tan2\theta_s = \frac{-(\sigma_x - \sigma_y)/2}{\tau_{xy}}$$

$$\tau_{max} = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + {\tau_{xy}}^2}$$

$$\sigma_{avg} = \frac{\sigma_x + \sigma_y}{2}$$

$$\sigma_{x'} = \frac{\sigma_x + \sigma_y}{2} + \frac{\sigma_x - \sigma_y}{2} \cos 2\theta + \tau_{xy} \sin 2\theta$$

$$\tau_{x'y'} = -\left(\frac{\sigma_x + \sigma_y}{2}\right) \sin 2\theta + \tau_{xy} \cos 2\theta$$

THE UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

UNIVERSITY EXAMINATIONS

END OF 2015/2016 ACADEMIC YEAR EXAM – SEPTEMBER 2016

EEE 2019

PRINCIPLES OF ELECTRICAL AND ELECTRONIC ENGINEERING

TIME: Three (3) hours

INSTRUCTIONS: Answer FIVE questions. Any THREE from SECTION A and Any TWO from SECTION B.

Each section must be answered in a separate book (s).

ADDITIONAL INSTRUCTIONS: Where not stated, resistances are in ohms. All questions carry equal marks. Total 100 Marks.

SECTION A

QUESTION 1

a) For the circuit shown in Figure Q1(a), use KVL and KCL to find the following:

i) i_Δ and v_o,

ii) Show that the total power supplied equals the total power dissipated in the resistors

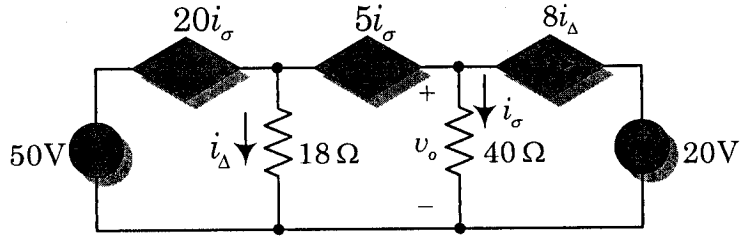


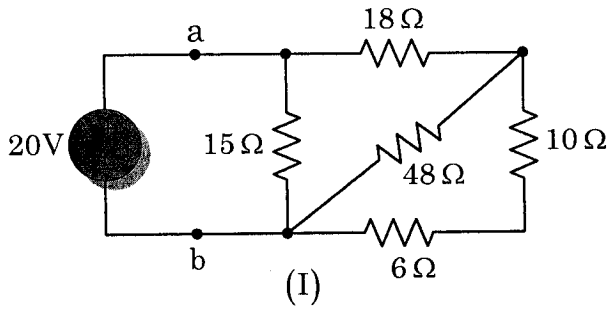
Figure Q1(a)

[8 Marks]

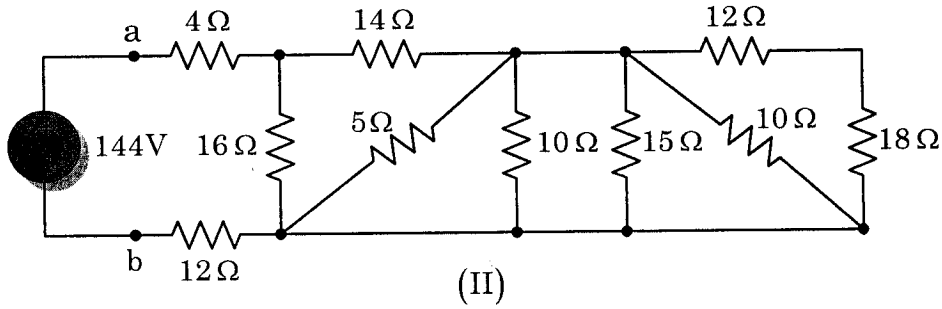
b) In the circuits shown in Figure Q1(b) starting with (I) and ending with (III),

i) Find the equivalent resistance R_{ab},

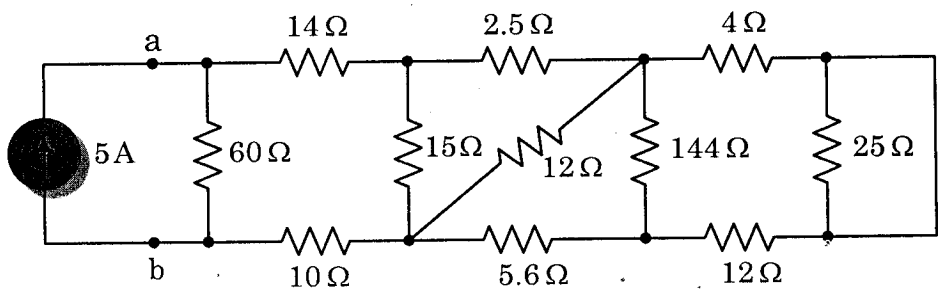
ii) For each circuit find the power delivered by the source.



(I)



(II)



(III)

Figure Q1(b)

[12 Marks]

QUESTION 2

a) Look at the circuit shown in Figure Q2(a),

i) Use current division to find the current flowing from top to bottom in the 10 kΩ resistor.

ii) Using your result from i), find the voltage drop across the 10 kΩ resistor, positive at the top.

iii) Using your result from ii), use voltage division to find the voltage drop across the 6 kΩ resistor, positive at the top.

iv) Using your result from iii), use the voltage division to find the voltage drop across the 5 kΩ resistor, positive at the left.

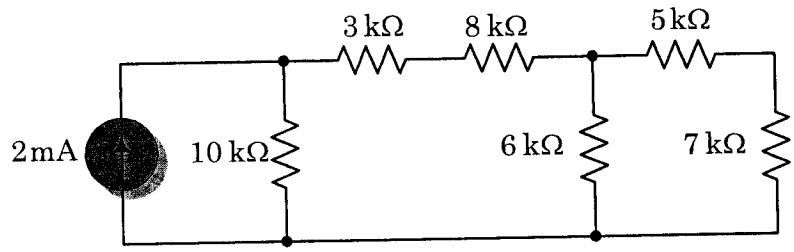


Figure Q2(a)

[12 Marks]

b) Use a Δ-to-Y transformation to find the voltages, v_1 and v_2 in the circuit shown in Figure Q2(b).

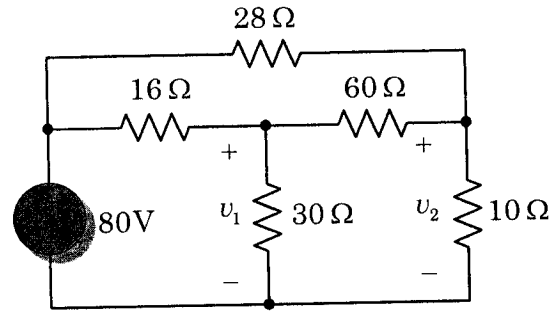


Figure Q2(b)

[8 Marks]

QUESTION 3

a) For the circuit shown in Figure Q3(a):

i) Use the node-voltage method to find v_1, v_3 and v_4 in the circuit shown in Figure Q3(a).

ii) Find the total power developed and the total power dissipated in the circuit.

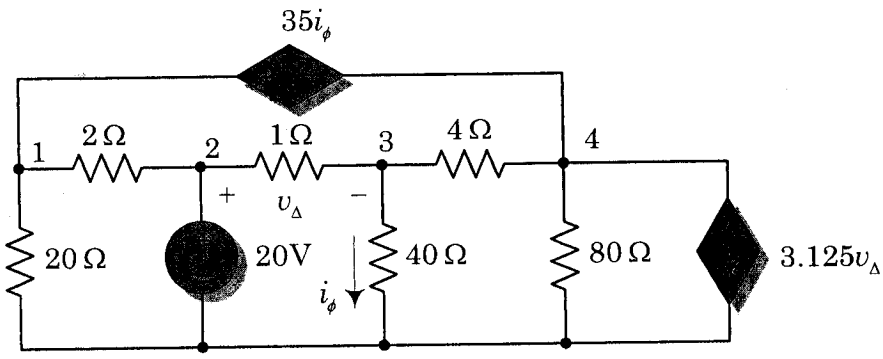


Figure Q3(a)

[10 Marks]

b) For the circuit shown in Figure Q3(b):

i) Use a series of source transformations to find the current in the 10 kΩ resistor.

ii) Using the result obtained in i), work back through the circuit to find the power developed by the 100 V source.

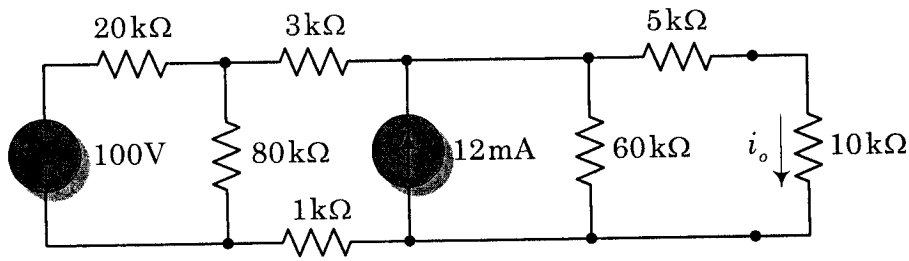


Figure Q3(b)

[10 Marks]

QUESTION 4

a) Use the principle of superposition to find the voltage v_o in the circuit shown in Figure Q4(a). **[10 Marks]**

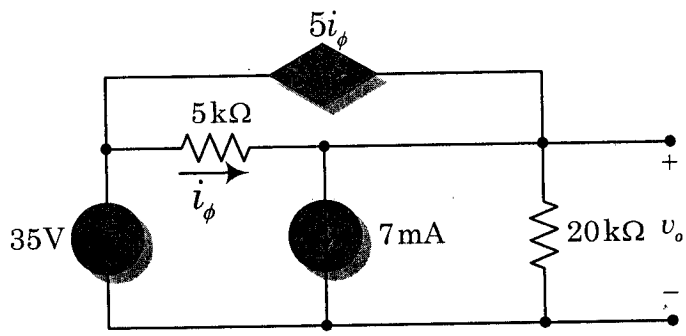


Figure Q4(a)

b) For the circuit shown in Figure Q4(b):

i) Use the mesh-current method to find the branch currents i_a, i_b, i_c, i_d, and i_e, in the circuit shown in Figure Q4(b).

ii) Check your calculations by showing that the total power developed in the circuit equals the total power dissipated.

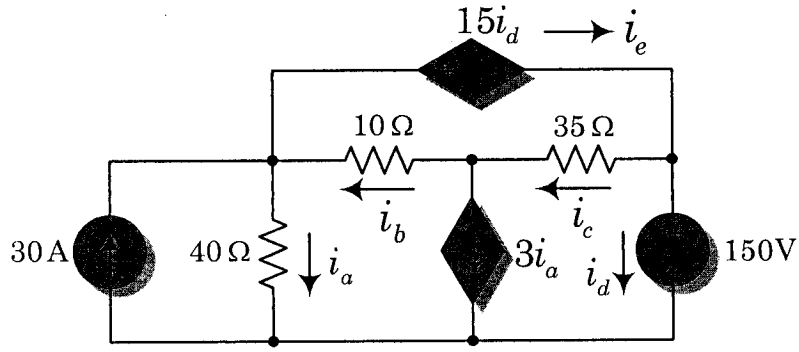


Figure 4(b)

[10 Marks]

SECTION B

QUESTION 5

a) Use the principle of superposition to find v_x in the circuit in Figure Q5(a). **[10 Marks]**

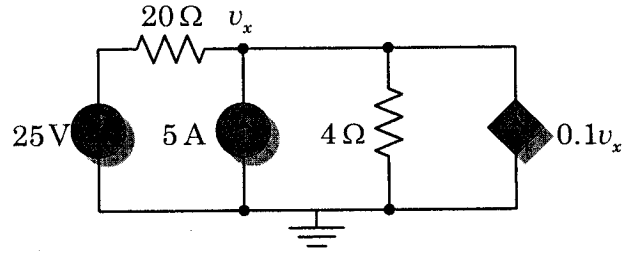


Figure Q5(a)

b) For the AC circuit in Figure Q5(b) use mesh analysis to determine i_o. **[10 Marks]**

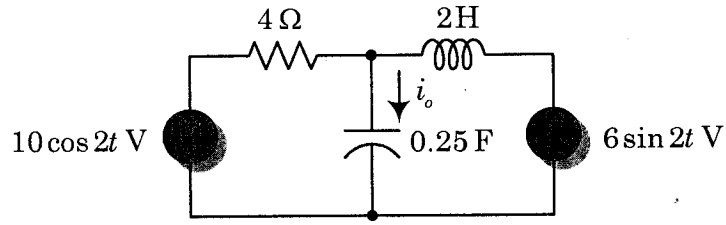


Figure Q5(b)

QUESTION 6

a) If the switch in Figure Q6(a) has been open for a long time and is closed at $t = 0$, find the inductor current $i(t)$ for $t > 0$. **[10 Marks]**

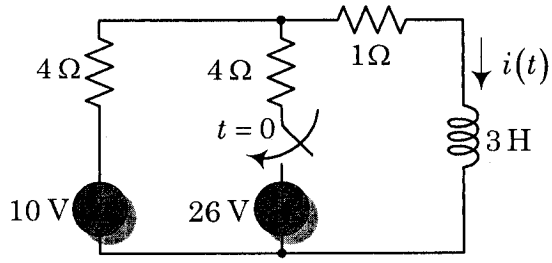


Figure Q6(a)

b) In the circuit of Figure Q6(b), load *A* receives 4 kVA at 0.8 power-factor leading, load *B* receives 2.4 kVA at 0.6 power-factor lagging, while load *C* is inductive and consumes 1 kW and receives 500 VAR.

i) Calculate the power factor of the entire system. **[8 Marks]**

ii) Determine $\mathbf{I}$ given that $\mathbf{V}_s = 120\angle 30^\circ$ V rms. **[2 Marks]**

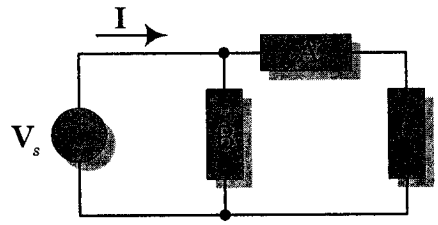


Figure Q6(b)

QUESTION 7

a) Draw a block diagram of a Regulated DC Power Supply and show input/output waveforms for each block. **[8 Marks]**

b) A power transmission system is modeled as shown Figure Q7. Find the real power and reactive power supplied and/or absorbed by: (i) the source, (ii) the line and (iii) the load. **[12 Marks]**

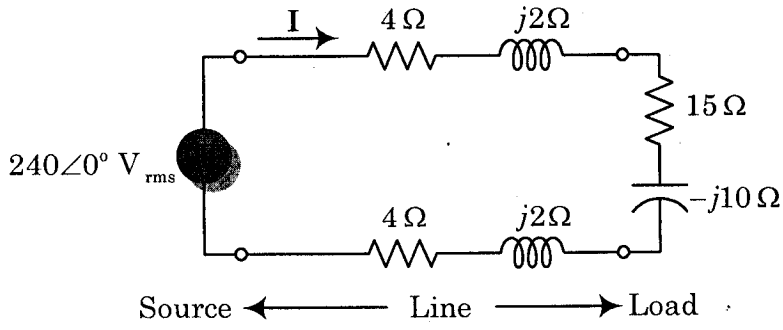


Figure Q7

QUESTION 8

a) The switch in Figure Q8(a) has been open for a long time and is closed at $t = 0$, determine the capacitor voltage $v(t)$ for $t > 0$. **[10 Marks]**

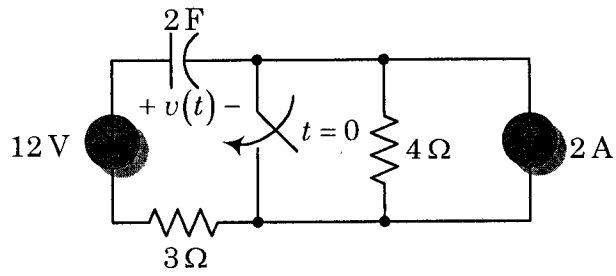


Figure Q8(a)

b) A Center-Tapped Transformer full-wave rectifier is shown in Figure Q8(b). The transformer has a 1:1 turns ratio. Thus, a primary winding sinusoidal voltage of 240Vrms, 50Hz gives full secondary winding voltage of 240Vrms, 50Hz. The rectifier output is connected to a 1 kΩ load resistor. Taking diodes to be ideal,

i) Sketch the output voltage, v_{out} across the 1 kΩ load resistor. **[3 Marks]**

ii) Calculate the DC voltage available at the load. **[3 Marks]**

iii) Determine the required peak-inverse-voltage (PIV) rating of each diode. **[2 Marks]**

iv) Find the maximum current through each diode during conduction. **[2 Marks]**

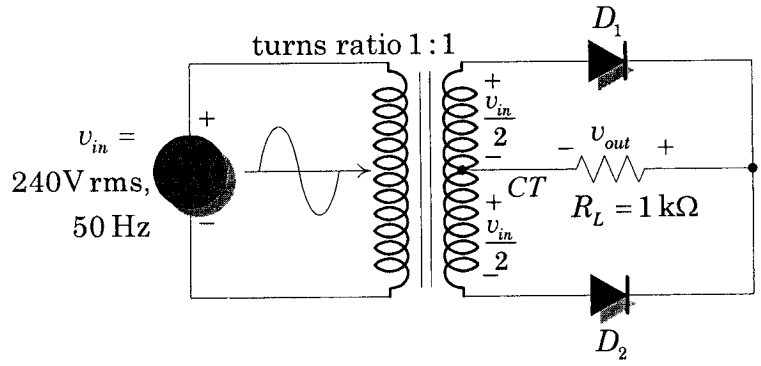


Figure Q8(b)

END OF EEE 2019 EXAM

THE UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

UNIVERSITY EXAMINATIONS
END OF YEAR – 26th September, 2016

ENG 2139

INTRODUCTION TO INFORMATION AND COMMUNICATION TECHNOLOGY (ICT)

TIME	:	**Three (3) hours**
INSTRUCTIONS	:	1. This exam paper has Seven (7) questions, organized in Section I (Question 1 – Question 4) and Section II (Question 5 – Question 7) 2. **Minimum of two questions** from each Section **must** be attempted. 3. Answers to each Section must be handed in separate booklet. 4. Show clearly all working steps leading to the answer.

SECTION I

Question one

(a) Explain the sequential architecture of modern computer systems and its impact on the performance of programs running on such platforms. **[5 marks]**

(b)

(i) Explain the term "Database Management Systems (DBMS). **[5 marks]**

(ii) Give a practical example of a Database Management Systems in today's distributed computing environment. **[4 marks]**

(c) Explain the role of the program counter in the execution of computer programs. **[6 marks]**

Question Two

(a) Explain how the hard disk drive (HDD) of a computer system can be used as an extended memory? **[7 marks]**

(b) During the computer system's rebooting process, there is one stage called "the loading of the operating system". Explain this phase as it occurs during the computer start-up. **[6 marks]**

(c) List and explain the types of buses you would find in a central processing unit (CPU) of a modern computer system. **[7 marks]**

Question Three

The operating system (OS) is very critical to the working a computer system. Among many of its main functionalities, there are security management and processor management.

a) How does the operating system's security management help the basic integrity of applications and data in a computer system? **[10 marks]**

b) And how does the operating system help an application programmer (developer) through its processor management module? **[10 marks]**

Question Four

(a) Define and explain the concept of a device called network switch. **[6 marks]**

(b) What is the difference between the Open Systems Interconnection (OSI) and Transport Communication Protocol and Internet Protocol (TCP/IP)? **[11 marks]**

(c) What makes it possible for a Dell laptop, an Xerox printer, an IBM desktop and an HP server to be connected together and work seamlessly well in a data network? **[3 marks]**

SECTION II

Question Five

(a) In mathematics, the factorial of a non-negative integer n, denoted by n!, is the product of all positive integers less than or equal to n. For example,

6! = 6 x 5 x 4 x 3 x 2 x 1 = 720

The value of 0! is 1, according to the convention for an empty product.

Write a program to calculate the factorial for any given number. Your program should include a function other than the main function **[5 marks]**

(b) In mathematics, the Fibonacci numbers or Fibonacci series or Fibonacci sequence are the numbers in the following integer sequence:

1 1 2 3 5 8 13 21 34 55 89 144 .....

By definition, the first two numbers in the Fibonacci sequence are 0 and 1, and each subsequent number is the sum of the previous two.

Calculate and display Fibonacci Series Using Loops **[5 marks]**

(c) Write codes using functions other than the main to generate and print N random numbers **[10 marks]**

Question Six

Write a program that takes in three arguments, a start temperature (in Celsius), an end temperature (in Celsius) and a step size. Print out a table that goes from the start temperature to the end temperature, in steps of the step size; you do not actually need to print the final end temperature if the step size does not exactly match. You should perform input validation: do not accept start temperatures less than a lower limit (which your code should specify as a constant) or higher than an upper limit (which your code should also specify). You should not allow a step size greater than the difference in temperatures. **[20 marks]**

Question Seven

Write a C++ program to answer student's inquiries. The program will display a menu that enables the users to choose whether they want to view all students 'records or view only the records of a specific student by the student's id. See sample below:

MENU

1. View all students' records
2. View a student's records by ID
3. Show the highest and the lowest final scores

Please enter your choice: 1

StudentID	Quiz1	Quiz2	Mid-Term	Final
1232	10	23	45	56
2343	45	43	24	78
2343	34	45	45	45
3423	67	6	65	56

[20 marks]

------- *END & GOOD LUCK!*-------

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF MECHANICAL ENGINEERING

UNIVERSITY EXAMINATIONS

FINAL END OF YEAR EXAMINATIONS, 2015

SEPTEMBER 2016

MEC 2309 – PROPERTIES OF ENGINEERING MATERIALS I
QUESTION PAPER

Read the following instructions carefully before you start writing:

1. **This Examination is Closed Book.**
2. **Time Allowed: Three (3) Hours.**
3. **Answer Any Five Questions, BUT with <u>At least Two (2)</u>, from Each Section.**
4. **<u>Hand in Sections A and B in Separate Answer Books</u>.**
5. **All questions carry equal marks.**

[DO NOT TURN THE PAGE OVER UNTIL YOU ARE TOLD TO DO SO]

SECTION A: Answer at least two questions from this Section

Question 1:
Thermal analysis of a number of alloys of lead (Pb) and tin (Sn) give the results in Table Q1.

Table Q1: Results of thermal analysis of various lead (Pb) and tin (Sn) alloys

Per cent Sn	0	5	10	15	18	20	40	62	90	98	99	100
Per cent Pb	100	95	90	85	82	80	60	38	10	2	1	0
1st arrest	330	320	305	295	285	280	235	180	220	230	232	235
2nd arrest	-	305	275	225	180	180	180	-	180	180	215	-
3rd arrest	30	110	145	170	-	-	-	-	-	150	120	30

The melting temperature of copper may be taken as 1080°C and that of pure silver as 960°C.

(a) Plot the phase diagram for the Pb-Sn alloy system on the graph paper provided as accurately as possible using the data given and label the important features on it. [10 marks]

(b) With the aid of sketches, describe the changes that would occur when the 62% Sn/38% Pb alloy composition is allowed to cool slowly from the liquid state to room temperature. [05 marks]

(c) For 40% Sn/60% Pb, state the phases present, their relative proportions and their compositions at 150°C [05 marks]

Question 2:

(a) Describe each of the following, stating their basic properties:
- (i) Ferrite. [02 marks]
- (ii) Austenite. [02 marks]
- (iii) Ludeburite. [02 marks]
- (iv) Martensite. [02 marks]

(b) Draw (not to scale) and fully label the steel phase of the iron-carbon phase diagram. [10 marks]

(c) A 0.6% carbon steel alloy is cooled from 722°C to 0°C. State the phase changes that take place and the temperatures at which these changes occur. [02 marks]

Question 3:

(a) Sketch a unit cell of the face-centred cubic crystal system and show the positions of the following (100), (110) and (111) planes. [06 marks]

(b) Show by calculation that the (111) planes in the face-centred cubic crystal system possess a greater density of atomic packing and a smaller inter-planner spacing than either the (100) or (110) planes. [14 marks]

Question 4:

(a) Use the data in Table Q4 to determine which is denser between copper and iron? [10 marks]

(b) Define the term "Coordination Number (CN)." With the aid of a sketch show that the co-ordination number of the bcc crystal structure is 8. [05 marks]

(c) Show that all atoms in the bcc crystal structure are lattice points. [05 marks]

Table Q4: Useful data for copper, iron and molybdenum

Element	**Symbol**	**Structure**	**Atomic mass (kg)**	**Lattice constant (nm)**
Copper	Cu	fcc	1.05359×10^{-25}	0.36147
Iron	Fe	bcc	9.26028×10^{-26}	0.28664
Molybdenum	Mo	bcc	1.59048×10^{-25}	0.31468

[PLEASE TURN OVER FOR SECTION B]

SECTION B: Answer at least two questions from this Section

Question 5:

(a) Explain what is meant by the following heat treatment terms as applied to plain carbon steels:

(i) Hardening. [05 marks]

(ii) Tempering. [05 marks]

(b) You have just been short listed to attend an interview at Universal Mining Company Industrial Limited (UMCIL) in Kafue. The company wishes to employ a Metallurgist who is competent in microstructural analysis.

(i) With regards to the procedure of mounting the specimen, explain how you would prepare a Y16 reinforcement bar specimen for microstructural analysis. Make reference to the equipment you have just worked on in Material science Laboratory at the University of Zambia. [06 marks]

(ii) Show the type of microstructure expected from this specimen. [04 marks]

Question 6:

Samples of pure copper in both the annealed and cold-worked conditions were subjected to Brinell hardness tests, using a 1 mm diameter ball indenter, with various loads. The test data are given in Table Q6.

Table Q6: Annealed and cold worked copper Brinell Harness test data

Material	Indenting Load (kg)	Indentation diameter (mm)
Annealed copper	5	0.386
	10	0.540
	15	0.636
Cold worked copper	10	0.375
	20	0.527
	30	0.632

(a) Calculate the Brinell hardness of the copper samples and their corresponding averages [10 marks]

(b) Define the following terms:

(i) Ductility.

(ii) Malleability.

(iii) Hardness.

(iv) Yield point.

(v) Limit of proportionality. [10 marks]

Question 7:

During tensile test on a cold worked brass, the results in Table Q7 were obtained for force (in kN) and extension (in mm). The diameter of the test piece d = 16 mm and the gauge length was 80 mm. After fracture the gauge length was 86.4 mm and the fracture point was 15.2 mm diameter.

Table Q7: Cold worked brass tensile test data

Ext(mm)	0.1	0.2	0.3	0.4	0.5	0.6	0.8	1.0	1.5	2.0	2.5	3	4	4.3
Force(kN)	23	46	69	82	89	94	102	110	123	131	136	139	132	118

(a) Draw the Force–Extension graph [10 marks]

(b) Determine

(i)	The Ultimate Tensile Strength (UTS).	[02 marks]
(ii)	Young's Modulus of Elasticity (E).	[02 marks]
(iii)	The 0.1% proof Stress.	[02 marks]
(iv)	The percentage elongation.	[02 marks]
(v)	Percentage reduction.	[02 marks]

Question 8:

Describe the structure and properties of the three main polymer groups:

(a)	Thermoplastic polymers.	[08 marks]
(b)	Thermosetting polymers.	[06 marks]
(c)	Elastomers.	[06 marks]

END OF ME 2309 EXAMINATION

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