SCHOOL OF MINING, METALLURGY & CHEMICAL ENGNEERING

DEPARTMENT OF METALLURGY

BEng Tech: Physical Metallurgy

SUBJECT:	**Welding Technology**
CODE:	**WLDMTB3**
ASSESSMENT:	**Main Exam 2019**
EXAMINAR:	**Prof. P.A. Olubambi**
MODERATOR:	**Dr. Nthabiseng Maledi**
DATE:	**Tuesday, November 12, 2019**
DURATION:	**3 hours**
TIME:	**12:30 – 15:30**
VENUE:	**G210, DFC Q/K Building**
TOTAL MARKS:	**120**

INSTRUCTIONS:

- **Use the appendices provided at the end of the question paper to answer some of the questions**
- **Scientific calculator is permitted**
- **Answer all the questions**

Question 1.

a) Write a short note on the five (5) different classification of joining processes. **(5 marks)**

b) You are a metallurgical engineer working with a group of other specialists on an industry related problem and due to your expertise, you were charged with the responsibility to recommend the best way to joining two or more electronic parts together. Based on this, answer the following:

- **i.** Which process will you recommend?
- **ii.** Justify the reason for selecting the process
- **iii.** List three (3) advantages of the selected joining process? **(5 marks)**

c) In a tabular form, list two similarities and three differences between fusion welding and solid-state welding. **(5 marks)**

d) Based on your knowledge of welding technology, answer the following questions **(10 marks)**:

- **i.** A fusion welding operation in which no filler metal is added is referred to as an autogenous weld. **True/False**
- **ii.** The slags used in flux shielded processes are designed to absorb deoxidation products and other contaminants. **True/False**
- **iii.** Filler metals are used in friction welding process (FRW). **True/False**
- **iv.** The microstructure of the welded joint does not depend on the cooling rate and chemical composition of the base metals. **True/False**
- **v.** Electron beam welding is a type of solid-state welding. **True/False**
- **vi.** The assemblage of parts that are joined by welding is called a weldment. **True/False**
- **vii.** Plastics can be joined using welding processes. **True/False**
- **viii.** Welding does not involve localized coalescence of two metallic parts at their faying surfaces. **True/False**
- **ix.** A seam weld is a type of arc and gas weld. **True/False**
- **x.** Lap, Butt and Tee joint are not a type of weld joint. **True/False**

Question 2.

a) With a mathematical expression, what is power density as related to welding operation? **(3 marks)**

b) You are a senior welding supervisor in an energy company. A young graduate trainee comes to seek your knowledge in tackling a welding calculation problem. He was performing oxy-acetylene operation with heat source of 3000 W transferred to the surface of a metal part. The heat impinges the surface in a circular area, with intensities varying inside the circle. The recorded distribution is as follows: 85% of the power is transferred within a circle of diameter 5 mm, and 70% is transferred within a concentric circle of diameter 12 mm. He wants to calculate the power densities in the:

i. 5 mm-diameter inner circle and
ii. 12 mm-diameter ring that lies around the inner circle? **(10 marks)**

c) Define and sketch any four (4) types of weld joint. **(12 marks)**

Question 3.

a) What are the four (4) factors that dictates the mechanical properties of a welded joint. **(4 marks)**

b) Welding is a complex process that involves:

i. Gas-metal and
ii. Slag-metal reactions.

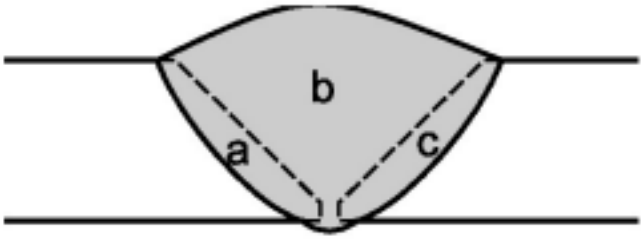
Explain these two phenomena as related to welding metallurgy. **(4 marks)**

c) Draw a schematic diagram of a "welded joint" with proper labelling. **(3 marks)**

d) Explain the "weld fusion zone" and distinguish between the three types of fusion weld **(5 marks)**

e) Explain the following **(5 marks)**:

- **i.** What is dilution?
- **ii.** List three factors that influence dilution
- **iii.** What does it mean when the dilution of a welding operation is 100%?
- **iv.** Write out the mathematical expression for calculating the dilution ratio of the weld given below:



f) Briefly explain the following **(4 marks):**

- **i.** solidification of fusion weld and
- **ii.** list three types of solification modes/morphologies and draw a typical cross-section of one of the mode.

Question 4.

a) With proper chemical equation, explain the two-stage reaction of acetylene and oxygen in gas welding. **(4 marks)**

b) Why is acetylene the most widely used fuel gas in oxy-acetylene gas welding? List three other types of gas that can be used in place of acetylene. **(4 marks)**

c) Explain the function of the following in gas welding **(3 marks):**

- **i.** Gas pressure regulators
- **ii.** Flashback arrestors
- **iii.** Welding torch

d) In the welding of two Aluminium Based material, the following values were obtained for the base metal (A6061) and filler metal (A4043) **(8 marks):**

Material	Cu	Fe	Mg	Mn	Si
6061	0.25	0.50	1.10	0.12	0.55
4043	0.30	0.80	0.05	0.05	5.20

What is the approximate composition of the final weld in each of the dilution given as 45% (High) and 10% (Low) respectively on two separate samples of the base metal? Note: the dilution contributed by the filler metal in high and low dilution would be 55% and 90% accordingly.

e) A plate of 12% Mn steel (Mn & Fe) is welded with a welding wire of composition 70% Mn – 30% Cr. What is the approximate composition of the final weld if there is 60% dilution of the plate (base metal) and 40% dilution of the welding wire (filler material)? Solve this problem in a tabular form as given below **(4 marks):**

Material	Mn	Fe	Cr
Plate			
Filler		-	
Total composition			

f) List two advantages of solid-state welding over fusion welding **(2 marks)**.

Question 5.

a) Explain the procedure involved in using the following NDT in establishing the quality of a weld:

I. Visual Inspection (VT). **(2 marks)**
II. Radiographic Inspection. **(2 marks)**
III. Magnetic Particle Inspection (MT). **(2 marks)**
IV. Liquid Penetrant Inspection (PT). **(2 marks)**
V. Ultrasonic Inspection (UT). **(2 marks)**

b) Using the table below together with the condition listed with it, what is the:
a. Maximum weld size and **(3 marks)**
b. Minimum weld size of the weld design shown below. (**2 marks)**:

Note : *(maximum weld size controlled by thin plate, minimum weld size controlled by thick plate).*

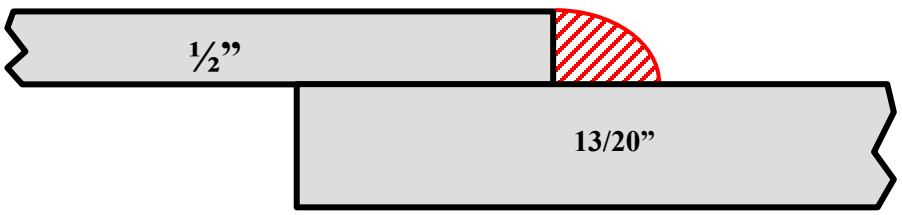


TABLE J2.4
Minimum Size of Fillet Welds

Material Thickness of Thinner Part Joined, in. (mm)	Minimum Size of Fillet Weld,[a] in. (mm)
To 1/4 (6) inclusive	1/8 (3)
Over 1/4 (6) to 1/2 (13)	3/16 (5)
Over 1/2 (13) to 3/4 (19)	1/4 (6)
Over 3/4 (19)	5/16 (8)

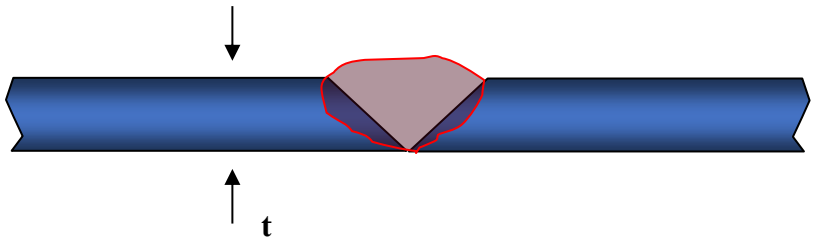
[a] Leg dimension of fillet welds. Single pass welds must be used.
Note: See Section J2.2b for maximum size of fillet welds.

The maximum size of fillet welds of connected parts shall be:

(a) Along edges of material less than 1/4-in. (6 mm) thick, not greater than the thickness of the material.

(b) Along edges of material 1/4 in. (6 mm) or more in thickness, not greater than the thickness of the material minus 1/16 in. (2 mm), unless the weld is especially designated on the drawings to be built out to obtain full-throat thickness. In the as-welded condition, the distance between the edge of the base metal and the toe of the weld is permitted to be less than 1/16 in. (2 mm) provided the weld size is clearly verifiable.

c) Calculate the effective area of the groove weld given below, if the length of weld (L_W) is 12" and effective throat thickness (t) is 3/8". **(5 marks)**



Appendices

- Effective area of groove weld:

$$A_w = t_e \times L_w$$

A_w = Effective area of weld.

t_e = Effective throat thickness.

L_w = Length of weld.