SAULT COLLEGE OF APPLIED ARTS AND TECHNOLOGY

SAULT STE. MARIE, ONTARIO

SAULT
COLLEGE

COURSE OUTLINE

COURSE TITLE: Welding Theory 1

CODE NO. : MTF102 **SEMESTER:** ONE

PROGRAM: Metal Fabricator Technician / Welding Techniques

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APPROVED:

"Corey Meunier"
CHAIR **DATE**

TOTAL CREDITS: THREE

PREREQUISITE(S): N/A

HOURS/WEEK: THREE

I. COURSE DESCRIPTION:

Describe the functions and controls of welding power sources in accordance with government safety regulations, manufacturer's recommendations and approved industry standards.

II. LEARNING OUTCOMES AND ELEMENTS OF THE PERFORMANCE:

Upon successful completion of this course, the student will demonstrate the ability to:

- Define the functions of welding power sources.
- Describe the effects of power source controls on welding processes.
- Define the fundamentals of the Shielded Metal Arc Welding (SMAW) process.
- Describe the equipment requirements for the Shielded Metal Arc Welding (SMAW) process.
- Describe the construction and characteristics of Shielded Metal Arc Welding (SMAW) electrodes.
- Describe the Shielded Metal Arc Welding (SMAW) procedure variables and their effects on quality and productivity.
- Define the fundamentals of the Gas Metal Arc Welding (GMAW) process.
- Explain safety concerns applicable to the Gas Metal Arc Welding (GMAW) process.
- Explain the function of the components of the Gas Metal Arc Welding (GMAW) process.
- Explain the selection and characteristics of consumables necessary for Gas Metal Arc Welding (GMAW) short-circuit transfer and spray-arc transfer.
- Describe the procedure variables for Gas Metal Arc Welding (GMAW) and their affect on quality and productivity.
- Define the fundamentals of the Flux Cored Arc Welding (FCAW) process and Metal Cored Arc Welding (MCAW) process.
- Explain the function of the components of the Flux Cored Arc Welding (FCAW) process and Metal Cored Arc Welding (MCAW) process.
- Describe the selection of welding parameters and consumables necessary for Flux Cored Arc Welding (FCAW) and Metal Cored Arc Welding (MCAW).
- Define the fundamentals of the Gas Tungsten Arc Welding (GTAW) process.
- Explain the safety concerns applicable to the Gas Tungsten Arc Welding (GTAW) process.
- Describe the required equipment and components for the Gas

Tungsten Arc Welding (GTAW) process.
- Explain the characteristics and selection considerations for consumables used for Gas Tungsten Arc Welding (GTAW) on steel.
- Explain the set-up and control of the process variables for the Gas Tungsten Arc Welding process.

1. Power Sources

Potential Elements of the Performance:

Define the functions of welding power sources.

- constant current
- constant voltage
- inverters
- transformers
- transformer rectifiers
- generators
- engine drives
- amperage controls
- principle of inductance
- tapped control
- saturable reactor
- shunt
- magnetic amplifier
- SCR

Describe the effects of power source controls on welding processes.

- amperage
- voltage
- voltage trim
- remote controls
- output characteristics
- current type
- polarity
- slope control
- inductance
- square wave
- high frequency
- AC balance
- transformer rectifier
- inverter
- welding current output frequency
- inverter controls

2. Shielded Metal Arc Welding

Potential Elements of the Performance:

Define the fundamentals of the Shielded Metal Arc Welding (SMAW) process.

- development of arc welding
- method of melting and freezing
- fusion
- arc characteristics
- arc length
- effect on voltage
- penetration
- travel speed
- optimum
- effects of too fast or too slow
- weld contamination protection

Describe the equipment requirements for the Shielded Metal Arc Welding (SMAW) process.

- power sources
  - transformers
  - rectifiers
  - inverters
  - generators
  - engine driven
- power source controls
  - amperage
  - duty cycle
  - voltage
  - current type
  - polarity
- arc force
- electrode holders
  - clamp
  - jaw types
- welding cables
  - cable size and condition
  - connectors
  - relationship to required amperage
  - work lead
  - completion of welding circuit
  - clamps in good repair
  - work lead locations

Describe the construction and characteristics of Shielded Metal Arc Welding (SMAW) electrodes

- basic construction features
  - core wire
  - flux covering
  - manufacturing methods of welding electrodes
  - electrode concentricity
  - functions of the flux coating
  - flux coating base material
  - chemical properties and alloying elements
  - shielding
- classification of Shielded Metal Arc Welding (SMAW) electrodes, CSA and AWS.
  - low hydrogen (basic)
  - cellulose
  - rutile
  - iron powder
  - mild steel
  - low alloy - stainless steel
  - meaning of each letter and numerical group
  - imperial and metric versions
  - storage and handling
  - electrode conditioning
  - storage temperatures

Describe the Shielded Metal Arc Welding (SMAW) procedure variables and their effect on quality and productivity.

- primary variables (conducted prior to welding)
  - joint design and fit-up
  - consumables
  - current type and polarity
  - amperage
  - pre-heat
  - electrode size
- secondary variables (conducted during welding)
  - travel speed
  - arc length
  - work angle
  - electrode angle
  - technique
  - whipping
  - weaving
  - stringer
  - multiple passes
  - drag

3. Gas Metal Arc Welding

Potential Elements of the Performance:

Define the fundamentals of the Gas Metal Arc Welding (GMAW) process.

- modes of metal transfer
  - short-circuiting transfer
  - spray arc transfer
  - globular
  - pulsed
- gas shielding
  - purpose - types
  - Argon / Helium
  - CO_2
  - mixed gases
  - triple mix gas

Explain safety concerns applicable to the Gas Metal Arc Welding (GMAW) process.

- UV radiation protection

- appropriate helmet and filter plate

- spatter and proper safety clothing
- storage and handling of high pressure cylinders
- flow meters
- fumes and gases
- oxygen depletion

Explain the function of the components of the Gas Metal Arc Welding (GMAW) process.

- fundamentals and characteristics of the Constant Voltage power source

- self- correcting arc gap

  - application of Constant Current power sources
  - wire feeders - spool guns - push type - push-pull type - drive rolls

- liners

  - metallic

- non-metallic - gas diffusers

  - contact tips / contact tubes

- nozzles

- water cooled guns

-radiation

  - Ultra Violet
  - Infra Red
  - white light

- noise
- fall protection
- falling objects

Explain the selection and characteristics of consumables necessary for Gas Metal Arc Welding (GMAW) short-circuit transfer and spray-arc transfer.

- optimal wire type and size (diameter)
- filler metal classification system
  - low alloy
  - steels
  - stainless steels
  - aluminium
  - types and sizes
  - purpose of copper plating
- shielding gas
  - types
  - flow rate

Describe the procedure variables for Gas Metal Arc Welding (GMAW) and their affect on quality and productivity.

- primary variables (conducted prior to welding)
  - joint design and fit-up
  - consumables
  - shielding gas
  - current type and polarity
  - amperage
  - wire feed speed
  - wire diameter
  - voltage
  - preheat
- secondary variables (conducted during welding)
  - travel speed
  - nozzle to work distance
  - work angle
  - gun angle to work
  - technique
  - stringer
  - multi-passes
  - weaving
  - forehand
  - backhand

4. Flux Core/Metal Core Arc Welding

Potential Elements of the Performance:

Define the fundamentals of the Flux Cored Arc Welding (FCAW) process and Metal Cored Arc Welding (MCAW) process.

- metallic transfer
- construction of the tubular wire
  - wire types
  - flux types
- gas shielding
  - purpose
  - types

Explain the function of the components of the Flux Cored Arc Welding (FCAW) process and Metal Cored Arc Welding (MCAW) process.

- fundamentals and characteristics of the Constant Current power source
- fundamentals and characteristics of the Constant Voltage power source
- electrode wire classification
  - types and sizes
- mechanical feeders
  - drive rolls
  - liners
  - contact tips
  - nozzles
- gas shielding
  - gas diffusers

Describe the selection of welding parameters and consumables necessary for Flux Cored Arc Welding (FCAW) and Metal Cored Arc Welding (MCAW).

- material thickness
- position of welding
- voltage
- wire feed speed
- wire type and size
- drive rolls
- contact tips
- selection of shielding gas
- types
- flow rate
- gun angle
- direction of travel

5. Gas Tungsten Arc Welding

Potential Elements of the Performance:

Define the fundamentals of the Gas Tungsten Arc Welding (GTAW) process.

- non-consumable tungsten electrode
- gas shielding of weld
- advantages of the Gas Tungsten Arc Welding (GTAW) process - no spatter
  - all position capable
  - precision
  - weld light gauge materials
  - high quality welds
  - concentrated high-temperature arc
  - wide variety of applications and alloys
- limitations of the Gas Tungsten Arc Welding (GTAW) process
  - deposition rates
  - pre-cleaning required

Explain the safety concerns applicable to the Gas Tungsten Arc Welding (GTAW) process.

- arc radiation
- heat
- air quality
- fumes
- gases
- oxygen depletion
- electrical
- high frequency
- thorium
- high pressure cylinders

Describe the required equipment and components for the Gas Tungsten Arc Welding (GTAW) process.

- power source
- fundamentals and characteristics of the constant current power source -equipment controls -welding currents -AC
  -DC electrode negative
  -DC electrode positive
  -high frequency (HF) circuit
- contactor and current control methods
  manual control - remote controls - foot control
  - torch thumbwheel
- shielding gas supply system
  - cylinders or bulk systems
  - regulator
  - flow meter
  - hoses
  - torches
  - air and water cooled
  - amperage rating
  - coolant circulators
  - collet and body
  - nozzle
  - gas lens

Explain the characteristics and selection considerations for consumables used for Gas Tungsten Arc Welding (GTAW) on steel.

- shielding gas
  - type
  - flow rate (imperial and metric)
- filler material
  - type (alloy) and classification
  - size
- tungsten electrode
  - type and grade
  - size – conditioning and contamination control

III. TOPICS:

1. Power Sources
2. Shielded Metal Arc Welding
3. Gas Metal Arc Welding
4. Flux Core / Metal Core Arc Welding
5. Gas Tungsten Arc Welding

IV. REQUIRED RESOURCES/TEXTS/MATERIALS:

- Modules: Course Pack for MTF102

V. EVALUATION PROCESS/GRADING SYSTEM:

Part 1 NOTES:

1. Re-writes are NOT allowed for any written assignment, quiz or test.
2. Repeats are NOT allowed for any shop test
3. Course attendance is mandatory. One percent (1 %) per hour will be Deducted from the final course grade for apprentices with more than 4 hours of unexcused* absence.

[Any absence without a written, valid reason will be deemed unexcused.]

Valid reasons would include:

- Doctor's note
- Apprenticeship Ministry note
- Family Death or Serious Illness supported by a written note.

Part 2 Final Course Grades:

The final course grade will be determined by means of the following list of weighted factors:

Factor	***Value***
Theory Quiz & Test	100 %
Attendance	-1% per Unexcused Hour

The following semester grades will be assigned to students:

Grade	**Definition**	*Grade Point Equivalent*
A+	90 – 100%	4.00
A	80 – 89%	
B	70 - 79%	3.00
C	60 - 69%	2.00
D	50 – 59%	1.00
F (Fail)	49% and below	0.00

CR (Credit)	Credit for diploma requirements has been awarded.
S	Satisfactory achievement in field /clinical placement or non-graded subject area.
U	Unsatisfactory achievement in field/clinical placement or non-graded subject area.
X	A temporary grade limited to situations with extenuating circumstances giving a student additional time to complete the requirements for a course.
NR	Grade not reported to Registrar's office.
W	Student has withdrawn from the course without academic penalty.

VI. SPECIAL NOTES:

Attendance:
Sault College is committed to student success. There is a direct correlation between academic performance and class attendance; therefore, for the benefit of all its constituents, all students are encouraged to attend all of their scheduled learning and evaluation sessions. This implies arriving on time and remaining for the duration of the scheduled session.

VII. COURSE OUTLINE ADDENDUM:

The provisions contained in the addendum located on the portal form part of this course outline.