



## COURSE OUTLINE: MTF102 - WELDING THEORY 1

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Approved: Corey Meunier, Chair, Technology and Skilled Trades

<b>Course Code: Title</b>	MTF102: WELDING THEORY 1
<b>Program Number: Name</b>	4051: METAL FABRICATION 4053: WELDING TECHNIQUES
<b>Department:</b>	IRONWKR APPR./WELDING RELATED
<b>Semesters/Terms:</b>	19F
<b>Course Description:</b>	Describe the functions and controls of welding power sources in accordance with government safety regulations, manufacturer recommendations and approved industry standards.
<b>Total Credits:</b>	3
<b>Hours/Week:</b>	3
<b>Total Hours:</b>	45
<b>Prerequisites:</b>	There are no pre-requisites for this course.
<b>Corequisites:</b>	There are no co-requisites for this course.
<b>Vocational Learning Outcomes (VLO's) addressed in this course:</b>	<b>4051 - METAL FABRICATION</b> VLO 2 Apply knowledge of various welding and metal cutting techniques and theories to produce components and sub-assemblies. VLO 5 Understand and use a variety of destructive and non-destructive methods to test welds.
<small>Please refer to program web page for a complete listing of program outcomes where applicable.</small>	
<b>Essential Employability Skills (EES) addressed in this course:</b>	EES 1 Communicate clearly, concisely and correctly in the written, spoken, and visual form that fulfills the purpose and meets the needs of the audience. EES 2 Respond to written, spoken, or visual messages in a manner that ensures effective communication. EES 11 Take responsibility for ones own actions, decisions, and consequences.
<b>Course Evaluation:</b>	Passing Grade: 50%, D
<b>Other Course Evaluation &amp; Assessment Requirements:</b>	1. Late hand in penalties will be -10% per day. 2. If a student misses a test/lab he/she must have a valid reason (i.e. medical or family emergency documentation shall be required). In addition, the instructor MUST be notified PRIOR to the test or lab sitting. If this procedure is not followed the student will receive a mark of zero on the test/lab with no make-up option. 3. Re-writes are NOT allowed for any written assignment, quiz or test. 4. Repeats are NOT allowed for any shop test. 5. Course attendance is mandatory. One percent (1 %) per hour will be deducted from the final course grade for unexcused* absence. *[Any absence without a written, valid reason will be deemed unexcused.]*  Valid reasons would include: Doctors note Family Death or Serious Illness supported by a written note.



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**Books and Required Resources:**

IPT's Metal Trades and Welding  
 Publisher: IPT Publishing and Training Ltd

Blueprint Reading & Welding Skills (Plus Workbook and PPM) by Bennett  
 Publisher: Nelson Canada

**Course Outcomes and Learning Objectives:**

Course Outcome 1	Learning Objectives for Course Outcome 1
<p>Upon successful completion of this course, the student will demonstrate the ability to:</p> <p>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</p>	<p>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</p> <p>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</p> <p>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</p>



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.

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<sub>2</sub>
- 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
- aluminum
- 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

**Evaluation Process and Grading System:**

Evaluation Type	Evaluation Weight
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Test 4	20%
Test 1	20%
Test 2	20%
Test 3	20%
Test 5	20%

**Date:** July 25, 2019

**Addendum:** Please refer to the course outline addendum on the Learning Management System for further information.

