Apprenticeship Manitoba

Manitoba

# Truck and Transport Mechanic
# Level 2

Rev. December 2004

Apprenticeship Manitoba

# Truck and Transport Mechanic

## Unit: C2 Welding (Electric/Arc/MIG)

**Level:** Two

**Duration:** 40 hours

Theory: 4 hours

Practical: 36 hours

**Overview:**

This unit of instruction is designed to provide the Truck and Transport Mechanic apprentice with the working knowledge required to use equipment and perform tasks related to electric, arc, and MIG welding.

| **Objectives and Content:** | **Percent of Unit Mark (%)** |
|---|---|

**1. Describe prerequisite knowledge of the electric arc welding process.** **4%**

a. Applied safety precautions
- Eye, face, hand, foot and clothing protection
- Cut and burn treatments
- Fire extinguisher availability
- Setup and shutdown sequence
- Ventilation equipment
- Cylinder and shutdown sequence
- Cylinder handling
- Electrical shock protection
- Vehicle electronic systems protection

b. Applied tools and equipment
- Compressed gas cylinders
- Pressure regulators
- Hoses
- Approved welding work place
- Ventilation equipment

c. Applied communications
- Interpretation of manufacturers' service and operating procedures
- Practical report
- Information accessing

**2. Describe the fundamentals of the electric arc welding process.** **4%**

a. Metallurgy
b. Arc emissions
c. Electrical polarity
c. Electrical fundamentals

**3. Describe the components and applications of electric arc welding equipment and** **4%**

**consumables.**

a. Transformers
b. Rectifiers
c. Controls
d. Electrode holders
e. Electrode specifications
   - Codes
   - Current type and polarity
   - Position
   - Penetration
   - Base metal material
   - Material condition

**4. Describe the operation of shielded electric arc welding equipment. 4%**

a. Equipment settings
b. Transformers
c. Rectifiers
d. Stationary and portable units
e. Open circuit voltage
f. Closed circuit voltage

**5. Perform electric welding procedures with A/C, D/C and MIG welding equipment. 80%**

a. Machine adjustments and welds
b. Single and multi pass butt and fillet welds in flat position
c. Examples of defective welds
d. Trial beads

**6. Describe manufacturers' maintenance procedures for shielded metal arc welding equipment. 4%**

a. Welding cables
b. Holding devices
c. Power sources
d. Protective equipment
e. MIG welder maintenance

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Apprenticeship Manitoba

# Truck and Transport Mechanic

## Unit: E2 Differentials, Drive Axles, Final Drives

**Level:** Two

**Duration:** 30 hours

Theory: 12 hours

Practical: 18 hours

**Overview:**

This unit of instruction provides the Truck and Transport Mechanic apprentice with the working knowledge required to diagnose, service and repair problems related to differentials, drive axles and final drives.

| **Objectives and Content:** | **Percent of Unit Mark (%)** |
|---|---|
| **1. Describe differentials and final drives: components and operation.** | **50%** |

a. Role and purpose

b. Types of final drives
- Straight axle driven
  -Rigid axle shaft: full-floating and semifloating axles
  -Flexible axle shaft
- Planetary drives
  -Operation
  -Parts construction

c. Differential assembly components
- Drive pinion and ring gears
- Differential pinions, side gears and pinion shaft
- Housing types
  -Integral
  -Non-integral
- Differential drive gears
  -Spur bevel
  -Spiral bevel
  -Helical
  -Hypoid
  -Amboid
  -Single and double reduction
- Gear set identification and timing
  -Hunting
  -Non-hunting
  -Partial hunting
- Drive pinion mounting
  -Straddle
  -Overhung
- Axle shafts
  -Live vs. dead axles
  -Full-floating

-Semi-floating
-Axle shaft bearings (radial vs. thrust loading) and adjustments

d. Differential operation
   - Interaxle differential

e. Differential locks
   - Mechanical locks
   - Hydraulic and air
   - Automatic “no-spin”
   - Limited slip differentials (clutch packs and brake cones)

**2. Describe the diagnosis, disassembly, inspection, testing, servicing and reconditioning / repair of RWD drive assemblies** **50%**

a. Final drive and differential assemblies
   - Limited slip differential assembly (loading, unloading and locking type)
   - Inspection of gear tooth contact pattern
   - Inspection of pinion bearing preload adjustment
   - Drive assemblies: diagnosis of vibration and noise
     -Worn, loose and damaged bearings
     -Gear noise
   - Gear backlash
   - Differential case bearing preload

b. Differentials: diagnosis of noise
   - Damaged differential gears and pinion shaft
   - Excessive clearance between pinion and ring gear
   - Excessive wear or loose and broken parts
   - Loose parts striking together
   - Vibrations or "chattering" around corner: clutch packs or cones

c. Differential disassembly, inspection and reassembly
   - Separation of shims, cups and caps
   - Uniform torque and alignment while installing ring gear
   - Adjustment of gear depth (shims) bearing preload
   - Gear patterns and backlash
   - Bearing damage
   - Ring and pinion gears: excessive runout and side play
   - Shim wear and damage

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Apprenticeship Manitoba

# Truck and Transport Mechanic

## Unit: E3 Manual Transmissions: Multi Countershaft and Autoshift

**Level:** Two

**Duration:** 20 hours

Theory: 6 hours

Practical: 14 hours

**Overview:**

This unit of instruction provides the Truck and Transport Mechanic apprentice with the working knowledge required to service and repair differentials, drive axles, final drives and clutch steering systems.

| **Objectives and Content:** | **Percent of Unit Mark (%)** |
|---|---|
| **1. Describe multi-countershaft transmission fundamentals, types and operation.** | **75%** |
| a. Overall concept, purpose and design | |
| b. Twin-countershaft | |
| c. Triple countershaft | |
| d. Auxiliary section | |
| e. Shift controls and operation | |
| f. Coolers, pumps and filters | |
| **2. Describe troubleshooting for multi-countershaft transmissions.** | **5%** |
| a. Preventative maintenance checks | |
| b. Transmission noises | |
| c. Slip-out of gear | |
| d. Shifting difficulty / sticking in gear | |
| e. Transmission servicing | |
| • Following individual manufacturers' service procedures | |
| **3. Describe timing procedures of twin countershaft transmissions.** | **10%** |
| a. Purpose of timing | |
| b. Timing of front section | |
| • Marking of drive gears and countershafts | |
| c. Timing of auxiliary section gears | |
| **4. Describe procedures of related transmission components.** | **10%** |
| a. Changing of input shaft | |
| • Disassembly | |
| • Reassembly | |
| b. Air control disassembly | |
| c. Gearshift lever and shift housing removal and reassembly | |
| • Automated shift housing | |

d. Output yoke removal
e. Auxiliary section removal
f. Clutch housing removal
g. Auxiliary section disassembly
h. Auxiliary section reassembly
i. Timing and installation of auxiliary countershafts
j. Main section disassembly
k. Main section reassembly
l. Timing of right countershaft
m. Air shift system troubleshooting

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Apprenticeship Manitoba

# Truck and Transport Mechanic

## Unit: E2 Hydraulic Transmissions, Torque Converters and Related Components

**Level:** Two

**Duration:** 20 hours

Theory: 8 hours

Practical: 12 hours

**Overview:**

This unit of instruction provides the Truck and Transport Mechanic apprentice with the working knowledge required to diagnose, service and repair problems related to hydraulic transmissions, torque converters, planetary gears and hydraulic retarders.

| **Objectives and Content:** | **Percent of Unit Mark (%)** |
|---|---|

**1. Describe torque converter fundamentals, including diagnosis, disassembly and reassembly.** — **10%**

a. Overall purpose
- Torque converters vs. fluid couplings

b. Basic design/components
- Impeller
- Turbine
- Stator

c. Conventional torque converter
- Components
  -Impeller
  -Turbine
  -Stator
  -Ground sleeve
  -Turbine and impeller vane angles
  -Half-guide rings
- Design
- Operation
- Torque converter variation/efficiency increases

**2. Describe planetary gear sets and drive combinations.** — **10%**

a. Overall purpose
b. Basic components
c. Planetary gear operation
d. Role of the planetary carrier
e. Drive combinations

**3. Describe hydraulic transmission fundamentals, including diagnosis, disassembly** — **70%**

**and reassembly.**

a. Transmission fluid
   - Purpose
   - Requirements
   - Cooling
   - Types, designations
   - Viscosity
   - Friction
   - Service intervals

b. Automatic planetary transmissions
   - Design
   - Hydraulic system
     -Rear governor
     -Modulator pressure regulator
     -Trimmer regulator valve and trimmer valve
     -Hold regulator valve
     -Priority valve
     -Front governor (lockup circuit)
     -Relay valves
     -Selector valves
   - Neutral operation
   - First-to-fifth and reverse-gear operation

c. Eight-speed forward, four-speed reverse countershaft transmission

**4. Describe the diagnosis and maintenance of hydraulic transmissions. 5%**

a. Basic troubleshooting
   - Mechanical failure
     -Noises from worn bearings, shafts or splines (planetary gears)
     -Isolated by transmission shifting through various ranges
   - Hydraulic system failure
     -Use of flow meters and test gauges

b. Maintenance procedures

c. Pressure testing

d. Torque converter stall test

e. Operator complaints
   - High temperature
   - Rough shifting
   - No transmission lockup

**5. Describe the fundamentals, operation and diagnosis of hydraulic retarders. 5%**

a. Overall purpose

b. Hydraulic retarder types
   - Flywheel retarder
   - Transmission retarder
   - Driveline retarder

c. Design
   - Stationary converter housing
   - Stationary brake housing
   - Rotor
   - Vanes
   - Pockets
   - Turbine shaft

d. Hydraulic piping and controls
   - Components

-Pump
-Pressure control valve
-Spool valve
-Oil cooler

- Operation

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Apprenticeship Manitoba

# Truck and Transport Mechanic

## Unit: F2 Steering Systems and Alignment

**Level:** Two

**Duration:** 25 hours

Theory: 15 hours

Practical: 10 hours

**Overview:**

This unit of instruction provides the Truck and Transport Mechanic apprentice with the working knowledge required to diagnose and repair steering axles, linkage and gears. The unit also provides the opportunity to gain knowledge of alignment procedures and steering geometry.

| **Objectives and Content:** | **Percent of Unit Mark (%)** |
|---|---|

**1. Describe steering geometry theory.** — **13%**

a. Ackerman's Principle
b. Parallelogram
c. Centre of gravity
d. Centrifugal force
e. Levers, mechanical advantage
f. Linear and angular measurement
g. Column phasing
h. Vehicle alignment angles and measurements
   - Caster, toe and camber
   - Steering axis inclination
   - Included angle
   - Turning radius
   - Ride height
   - Thrust line
   - Centre line
   - Setback
   - Tracking

**2. Describe steering linkage operation and service.** — **13%**

a. Parallelogram steering linkage
   - Pitman arm (wear vs. nonwear)
   - Idler arm
   - Steering links
   - Knuckles

**3. Describe/Perform inspection, testing and diagnostic, testing and removal / replacement procedures on steering axle/linkage components.** — **14%**

a. Procedures
   - Visual inspection

- Wheel alignment
- Steering axle stops
- Knuckle vertical play inspection
- King pin fit inspection: upper and lower bushings
  -Adjustment of knuckle vertical play
- Upper/lower bushing torque deflection test
- Steering component integrity
  -Excessive steering wheel play
  -Tie rod wear
  -Idler arm wear
  -Pitman
  -Pulling and drifting
  -Shimmy

b. Describe steering axle component removal and replacement
- Overall preliminary steps
- Steering knuckle disassembly
- Knuckle pin removal
- Cleaning
- Knuckle pin grease seal replacement
- Knuckle assembly
- Steering linkages

**4. Describe the design and operation of manual steering gears; describe and perform the diagnosis/servicing of manual and power steering gears. 20%**

a. Steering gear design and operation
- Overall purpose
- Worm and roller gears
- Recirculating ball
- Cam and lever

b. Diagnosis and service
- Mesh and backlash
- Preloads
- Measurement and adjustment of preloads
- Steering system centering
- Dismantling, inspection, reassembly and adjustment of manual/power steering gears
- Lubrication
- Power steering pressure testing

**5. Describe wheel alignment theory, angles, suspension geometry, front axles, and axle alignment; describe the operation of alignment equipment; describe and perform the inspection/diagnosis of wheel alignment faults and alignment procedures. 20%**

a. Wheel alignment theory, angles and suspension geometry
- Centre of gravity
  -Centrifugal force
  -Linear and angular measurement
- Vehicle alignment angles and measurement
  -Caster
  -Camber
  -Toe
  -Steering axis inclination
  -Included angle
  -Turning radius
  -Ride height
  -Thrust line

-Centre line
-Setback
-Track
-Tire pressures

b. Axle alignment
   - Overall purpose/concept
   - Two-wheel geometric centre line alignment
   - Trailer tracking
   - Measurement
   - Axle offset
   - Trailer axles

c. Wheel alignment adjustments / procedures and fault diagnosis
   - Fault diagnosis
   - Shim adjustments
   - Eccentric adjustments
   - Strut rod adjustments
   - Elongated holes (slots)
   - Rear wheel alignment
     -Tracking/thrust angle

d. Operation of alignment equipment; inspection / diagnostic procedures and performing alignment angles.
   - Operating procedures of alignment equipment
   - Suspension component checks
     -Visual (Ride height, Tire pressure, Angles)
   - Light beam alignment systems
   - Trailer axles
   - Computerized alignment systems

e. Alignment procedures
   - Observations
     -Equipment setup
     -Alignment readings
     -Specifications comparison
     -Adjustment changes
   - Vehicle alignment: adjustments and corrections
     -Chassis trim height
     -Rear wheels, camber and toe settings
     -Front wheels (Caster/shims, camber/axle bending, toe-in, steering axis inclination, turning angles)
   - Diagnosis of steering and alignment complaints

f. Front axles
   - Types
     -Dead and alive axles
     -Steering axles
   - Weight ratings

**6. Describe steering axles and components; describe procedures for steering axle removal, overhaul, replacement and installation; describe and perform steering axle inspection and diagnosis.** **20%**

a. Steering axles and their components
   - Overall purpose
   - General description re: axle type
   - Tube, beam, iron bar configuration
   - Coil springs
   - Leaf springs
   - Torque bars
   - Hydropneumatic mounting

- King pin / ball joint
- Wheel hub and spindle
- Single disk / demountable disk wheel

b. Steering axle inspection and diagnosis
- General inspection
- Wheel alignment
- Steering axle stops
- Tie-rod ends
- Knuckle thrust bearings
- Knuckle pins
- Wheel bearings
- Knuckle vertical play
- Knuckle pin fit: upper bushing
- Lower bushing
- Upper bushing torque deflection test
- Lower bushing torque deflection test
- Tie-rod inspection
- Wheel bearing inspection
- Adjustment of knuckle vertical play

c. Removal, overhaul, replacement and installation steering axles and components
- Preliminary steps
- Steering knuckle disassembly
- Knuckle pin removal, cleaning and grease seal replacement
- Kingpins
  -Inspection
  -Replacement of pins and bushings
  -Types
- Knuckle pin bushing replacement
- Steering knuckle assembly
- Coil springs
- Tie-rod end replacement

d. Selection and use of grease lubrication
- Properties
  -Function
  -Classification
  -Selection
- Grease types
  -Wheel bearing
  -Universal joint
  -Chassis
  -High temperature
  -Multipurpose

e. Lubrication of vehicle chassis
- Grease gun (hand and air)
- Lubrication lines
- Grease fitting
- Refilling the grease gun
- Grease gun adapters
- Oilers
- Grease storage and handling
- Lubricating charts

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Apprenticeship Manitoba

# Truck and Transport Mechanic

## Unit: F3 Suspension Systems and Frames

**Level:** Two

**Duration:** 20 hours

Theory: 16 hours

Practical: 4 hours

**Overview:**

This unit of instruction provides the Truck and Transport Mechanic apprentice with the working knowledge required to understand, diagnose, repair and service truck systems and frames.

| **Objectives and Content:** | **Percent of Unit Mark (%)** |
|---|---|

**1. Describe the fundamentals of chassis frames, basic frame types, and design.** **10%**

a. General purpose and description
b. Drop-style crossmember frame
c. C-channel rail type frame
d. Key components of basic frame design
   - Yield strength
   - Section modules
   - Resist bend movement
   - Area
   - Applied moment
   - Bending moment
   - Margin of Safety
   - Frame rail types
     -Steel and aluminum alloy
   - Frame construction
   - Frame reinforcements
     -Inside/partial inside reinforcements
     -Outside reinforcements
     -Mid-frame "deep section" extensions
   - Role of frame rail web: attachments
   - Configurations
     -Two-element rail
     -Three-element rail
     -Four-element rail
     -I-beam
     -Box

**2. Describe frame damage, frame repair and alignment.** **10%**

a. Causes of frame damage
   - Impact
   - Cracks: overloading

- Corrosion

b. Importance of alignment; consequences of misalignment

c. Diagnosis of misalignment conditions
   - Front end alignment
   - Frame damage / bent axle housings
   - Brakes
   - Drive axle alignment

d. Procedures for checking frame alignment
   - Equal offset vs. straight frame rail assembly

e. Frame alignment procedures

**3. Describe the repair or replacement of frames, side rails and crossmembers. 15%**

a. Causes of frame damage and stress
   - Section changes
   - Incorrect bolt patterns and loose bolts
   - Notches and cracks
   - Improper load concentrations

b. Frame reinforcement: aftermarket modifications
   - Limits of gross vehicle/axle weight rating
   - Provincial standards
   - Related stresses in frame

c. Recommended welding procedures and precautions
   - Procedures for repairing cracks, using reinforcements, and cutting frames
   - Safety considerations

d. Drilling the frame
   - Safety precaution: existing drill holes
   - Other safety precautions

e. Bolt/fastener and torque specifications
   - Use in attaching a reinforcement
   - Use of manufacturers' specifications
   - Precautions: enlarged or irregularly worn holes
   - Precautions: aluminum frame components

f. Bolt attachments
   - Advantages of bolting
   - Placement of holes to minimize flange stress
   - Preferred use of existing holes
   - Strategic drilling of holes in side rail web
     -Manufacturers' specs
   - Avoidance of drilling holes in side rail flanges

g. U-bolts and clamp attachments
   - Advantages vs. other methods
   - Limitations: torque loads
   - Guidelines in applications

**4. Describe suspension system fundamentals, types and components; perform service checks. 35%**

a. Suspension system types and components
   - Solid axles
   - Spring steel
   - Tempered steel
   - Synthetic rubber
   - Fibre composites

- Pneumatics and hydraulics
- Frames and chassis types
  -Full frame
- Spring types
  -Coil
  -Leaf
  -Torsion bar
  -Air springs
- Shock absorbers
- Control arms and bushings
- Stabilizers
  -Radius rods
  -Strut rods
  -Track bars

b. Suspension system fundamentals
- Hook's Law
- Centre of gravity

c. Rear suspension types and performance of service checks
- Single-axle
- Tandem-axle
- Torque rods
- Equalizing beams
- Leaf-type springs
- Rubber cushion type
- Torsion bars
- Air bags
- Radius rod
- Service checks
  -U-bolts
  -Spring ends
  -Shackle brackets
  -Spring pins
  -Shock absorbers
  -Radius rods
  -Equalizers

**5. Perform inspection and testing procedures on suspension system components and subassemblies.** **10%**

a. Appropriate safety procedures

b. Suspension systems
- Visual inspection
- Ride height
- Corrosion
- Abnormal noises

c. Springs
- Spring condition and deflection
- Corrosion
- Abnormal noises

d. Shock absorbers
- Leaks
- Action
- Attachment

e. Suspension system inspection
- Control arm bushing
- Control arm sag

**6. Describe and perform the removal, replacement and servicing of suspension components.** **20%**

a. Removal and replacement of shock absorbers
b. Removal and replacement of leaf springs
   - Spring hangers
   - U-bolts
   - Spring clips
c. Servicing of air bag (spring) suspensions
d. Servicing of equalizing beam suspensions
e. Servicing of rubber cushion type suspensions
f. Adjustment and replacement of torsion bars
g. Servicing spring suspension with torque rods
   - Maintenance; alignment methods
h. Strut rod and trackbar bushings
i. Sway bar bushings and linkages

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Apprenticeship Manitoba

# Truck and Transport Mechanic

## Unit: H2 Hydraulic Accessories, Components and Circuits

**Level:** Two

**Duration:** 15 hours

Theory: 12 hours

Practical: 3 hours

**Overview:**

This unit of instruction provides the Truck and Transport Mechanic apprentice with the working knowledge required to work on hydraulic accessories, components and circuits.

| **Objectives and Content:** | **Percent of Unit Mark (%)** |
|---|---|
| **1. Describe basic hydraulic principles, components, operation and maintenance procedures.** | **40%** |

a. Basic hydraulic principles

- Pascal's Law
- Multiplication of force
- Formulas: area, pressure, force
- Displacement
- Thermal expansion
- Bermoulli's principle
- Advantages of hydraulic systems
- Force
- Energy (potential, heat, kinetic)
- Work
- Power
- Torque
- Pressure gauge
- Absolute pressure
- Hydraulic fluid properties
  -Viscosity
  -Friction
  -Flow rate
  -Volume
  -Velocity
  -Pressure
  -Cavitation
  -Imperial/metric
  -Pour point
  -Lubricating ability
  -Oxidation resistance
  -Corrosion and rust protection
  -Foaming and emulsion resistance

- Application of hydraulic systems
- Appropriate selection of hydraulic fluids
- Avoidance of contaminants

b. Hoses, fluids, fittings, tubing, filters: installation
   - Filters and strainers
     -Construction (surface and depth, sizes, micron rating, beta ratio)
     -Contamination (internal sources)
     -Ratings (absolute, nominal, beta)
     -Locations (strainer, pressure and return line filters)
   - Filter bypass devices and restriction indicators
     -Oil viscosity
     -Filter media permeability
   - Pipes and tubes
     -Copper, aluminum, plastic and steel
     -Sizing
     -Pipe connections and fittings
     -Flared tubing connections
     -Flawless tubing connections (split-flange, compression)
   - Pipe couplers
   - Quick disconnect couplers
   - Tube fittings
     -Flared
     -Compression fittings
     -Tightening procedures
   - Hoses
     -Fabric braid
     -Single and double-wire braid
     -Spiral-wire fittings and couplers
     -Sizes
     -Connectors and couplers
     -Adapters
   - Hose fittings
     -Permanent
     -Reusable
     -Installation
   - Seals
     -Static and dynamic (positive and non-positive)
   - Fluids
     -Viscosity, additives
   - Fluid circuits

c. Maintenance procedures for hydraulic components
   - Hydraulic oil and its service requirements
     -Function
     -Classification and selection
     -Safety precautions (blocking procedures, releasing system pressure)
     -Fluid and lubricant leaks: common causes
     -Indicators of oil contamination
     -Other indicators re: oil change
     -Type and grade
     -Cleanliness
     -Consequences of mixing different types/grades of oil
   - Removal and replacement of filters, strainers and conditioners
     -Draining of oil
     -Cleaning or replacement of filtration devices
     -Refilling the system (proper oil level)
     -Type and grade
     -Proper oil level
     -Machinery operation re: oil (flushing the system)

d. Basic hydraulic system components

- Pumps
- Hydraulic actuator
  -Linear
  -Rotary
- Pressure control valve
- Directional control valve
- Volume control valve
- Reservoir
  -Functions
  -Types
  -Features
- Cylinders
  -Single and double acting
  -Series telescoping
- Heat exchangers and operation
  -Overall purpose
  -Oil heaters
  -Oil coolers (system efficiency and duty cycles)

e. Hydraulic pump operation
- Overall purpose
- Basic pump cycle
- Pump displacement
  -Non-positive displacement pumps
  -Positive displacement pumps
- Pump flow ratings
- Pump efficiency
  -Mechanical efficiency
  -Volumetric efficiency
- Pressure rating
- Pump inlet design
  -Cavitation
  -Aeration
- Gear type pumps
  -Overall purpose
  -External gear pumps
  -Internal gear pumps (non-positive displacement pumps)
- Vance pumps
  -Overall purpose
  -Unbalanced vane pumps
  -Balanced vane pumps

f. Hydraulic valve operation
- Overall purpose
- Pressure control valves
  -Normally open
  -Normally closed
- Flow control valves
  -Principles of hydraulic flow control
  -Types (fixed and variable)
- Directional control valves
  -Construction (poppet, rotary, spool directional)
  -Actuation methods (mechanical)
  -Valve centre and work port condition (open centre)

g. Hydraulic cylinder operation
- Overall purpose
- Single acting
- Double acting
- Construction
- Weighted

- Spring loaded
- Gas-charged
  -Piston
  -Bladder
- Piston
- Bladder

h. Maintenance procedures for hydraulic system components
- Removal and replacement of filters, strainers and condition
- Interpretation of circuit schematics and symbols

**2. Describe the operation of an open centre hydraulic system. 10%**

a. Operating principles

b. Applications
- Two-line truck box hoist hydraulic system
  -Reservoir
  -Dump valve assembly
  -Hoist cylinder
- Three-line truck box hoist hydraulic system

**3. Describe hydraulic system diagnosis/troubleshooting, testing, and procedures for removing and replacing system components. 50%**

a. Diagnosis of common faults in hydraulic systems
- Gathering of information (manufacturers' service information)
- Discussion with operator
- Visual inspection
- Operational testing
  -Warming of hydraulic oil
  -Measurement of actuator cycle times
  -Check of hydraulic stall speed
  -Testing of hydraulic cylinders
- Use of hydraulic test equipment
  -Pressure testing (neutral, working and maximum system pressure)
  -Flow testing (actuator / flow meter testing)
- Analysis of information
- Conclusion of analyzed information

b. Causes of hydraulic system component failure
- Diagnosis of failure – failure analysis
- Contamination failures
  -Built-in
  -Ingressed
  -Internally generated
- Overpressure failures
- Cavitation failures
- Aeration
- Wear (abrasion, erosion, adhesion)

c. Hydraulic circuit troubleshooting and testing
- Preliminary checking
- Oil supply system
- Pump efficiency
- Main relief valve
- Individual circuits
- Low/high pressure secondary relief valves
- Poppet valves
- Circuit efficiency
- Drift testing

- Preventative maintenance
- Flushing procedure

d. Procedures for removing and replacing hydraulic system components
   - General safety precautions
   - Importance of manufacturer's manual
   - Hydraulic lines and fittings
     -Maximum pressure rating
     -Capacity
     -Line type
     -Steel pipe
     -Steel tubing
     -Hoses
   - Replacement of major hydraulic components
     -Importance of cleanliness
     -Proper lifting techniques
     -Pump and motor coupling condition and alignment
     -Directional control valve replacement
     -Adjustment of system relief valve

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Apprenticeship Manitoba

# Truck and Transport Mechanic

## Unit: I2 Basic Electronic Components

**Level:** Two

**Duration:** 25 hours

Theory: 21 hours

Practical: 4 hours

**Overview:**

This unit of instruction provides the Truck and Transport Mechanic apprentice with the working knowledge required to diagnose and repair problems related to basic electronic components.

| **Objectives and Content:** | **Percent of Unit Mark (%)** |
|---|---|
| **1. Describe electrical components, their design and operation.** | **80%** |

a. General electrical components and their operation

- Resistors: purpose
  -Limit current flow
  -Protect electrical parts
  -Protect electrical circuits
- Resistor types
  -Fixed resistor
  -Ballast resistor
  -Tapped resistor
  -Variable resistors
  -Rheostat
  -Potentiometer – three wire resistor
  -Thermistor
- Switches
  -Toggle
  -Single-pole, single-throw
  -Single-throw, double-pole
  -Double-throw, double-pole
  -Normally closed
  -Push-pull
  -Rotary
  -Thermal
  -Pressure
  -Mercury
- Types and uses of capacitors
  -Purpose (construction, charge, discharge cycle)
  -Uses (noise suppressor, counter voltage spikes)
  -Types (fixed, variable)
  -Identification (size, farads)
- Circuit protection devices
  -Purpose
  -Types (cartridge, blade, inline, fuse and fusible link)
  -Rating

-Role of service manuals
- Reluctors
- Circuit breakers vs. fuse
  -Flashers
  -Light bulbs
  -Coils
  -Transformers
  -Relays
  -Buzzers
  -Solenoids
  -Motors

b. Semiconductor design and types
- Semiconductor material
  -Crystal material
  -Sand – silica or silicon
  -Doping of silicon (adding phosphorus, boron, etc.)
- N-type semiconductor
- P-type semiconductor
- Diode construction
  -Joining of P and N material
  -Blocking and passing of current
  -Design of electrical check valve
  -Forward and reverse bias
- Thysistors
- Hall-effect chip
- Piezo crystals
- Photonic semiconductors
  -Light emitting diodes
  -Fiber optics

c. Transistors
- Purpose and design
  -Use in solid circuitry
  -Change from a resistor to conductor
  -Construction: joining of three semiconductor chips
  -NPN and PNP
  -Bonding of chips
  -Small wire attached to each type material
- Transistor connections
  -Emitter
  -Collector
  -Base
- Transistor operation
- Common types of transistors
  -Signal transistor
  -Power transistor

**2. Inspect and test electronic components. 10%**

a. Resistors
b. Diodes
c. Transistors
d. Switching circuits
e. Reluctor
f. Piezo crystals

**3. Identify and repair electronic connectors. 10%**

a. Deutsch connector
b. Weather patch

Apprenticeship Manitoba

# Truck and Transport Mechanic

## Unit: I3 Starting Systems

**Level:** Two
**Duration:** 30 hours
Theory: 15 hours
Practical: 15 hours

**Overview:**

This unit of instruction provides the Truck and Transport Mechanic apprentice with the working knowledge required to diagnose as well as repair problems related to starting systems.

| **Objectives and Content:** | **Percent of Unit Mark (%)** |
|---|---|

**1. Describe the design and operation of starter motor circuits and drives.** **45%**

a. Starter circuit
- Battery and cables
- Series and series-shunt
- Series-parallel
- Counter-electromotive force effect on current flow
- Temperature effect on load and torque output
- Relay controlled cranking circuits
- Solenoid controlled cranking circuits
- Combination relay and solenoid-controlled cranking circuits
- Control circuits (starting safety switch)
- Thermal protection circuit

b. Starting motor types and components
- Motor components
  -Armature
  -Windings
  -Commutator
  -Brushes and Springs
- Gear reduction
- Permanent magnet type
- Positive engagement moveable pole shoe drive
- Series-wound
- Compound wound
- Parallel wound

c. Starting motor drives
- Over-running clutch
- Disengagement protection
- Sprag
- Positork

- Friction-clutch

d. Types of starters
   - Electric
   - Air
   - Hydraulic

e. Starter switches
   - Magnetic
   - Solenoid
   - Series-parallel switch
   - Manual

**2. Describe and perform starting system troubleshooting; describe procedures to service air starting systems.** **45%**

a. Troubleshooting
   - Temperature
   - Battery conditions and ratings
   - Engine loads
   - Oxidation and corrosion of connections
   - Cable sizes and condition
   - Excessive starting time and overheating

b. Air starting systems
   - Air motor starting systems
     -Circuitry (valve and supply systems)
     -Operating principles
     -Applications (RPM)
     -Motor types
   - Drive mechanisms
   - Maintenance procedures (including lubrication provisions)
   - Operational hazards and precautions

**3. Describe procedures to service and repair starting aid components.** **10%**

a. Glow plugs
b. Intake manifold heater
c. Fluid starting aids
d. Battery warmer

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Apprenticeship Manitoba

# Truck and Transport Mechanic

## Unit: I4 Charging Systems

**Level:** Two

**Duration:** 30 hours

Theory: 15 hours

Practical: 15 hours

**Overview:**

This unit of instruction provides the Truck and Transport Mechanic apprentice with the working knowledge required to diagnose and repair problems related to charging systems.

| **Objectives and Content:** | **Percent of Unit Mark (%)** |
|---|---|

**1. Describe charging system fundamentals, control circuits, alternators, and voltage regulators.** **60%**

a. Magnetism and inductance

- Element
- Atom
- Compound
- Molecule
- Permeability
- Inductance
- Insulators
- Holes
- Inductance
- Magnetic field
- Permeability
- Retentivity
- Natural magnet
- Electromagnet construction
- Electron flow and magnetism
- The right hand rule
- Use of electromagnets on vehicles
- Conversion of energy by magnetism
  -Electrical energy into mechanical energy
  -Mechanical energy into electrical energy
  -Electrical energy into other forms
- Self-induction
- Mutual induction
- Examples of induction, self-induction and mutual induction
  -Ignition coil
  -Alternator
  -Starter

b. Charging systems fundamentals and control circuits
   - Overall principles
   - Induced density
   - Alternators (AC generators)
   - Voltage regulation
   - Factors affecting voltage and amperage output
     -Battery condition and temperature
     -Circuit condition
     -Engine speeds
     -Hysteresis
     -Copper

c. Design and function of alternators, voltage regulators and charging systems
   - Charging systems by field control
     -AandB type
   - AC generator (alternator) types
     -Brushless
     -12 and 24-volt
     -Oil-cooled
   - AC generator (alternator) construction
     -Rectifier
     -Diodes
     -Stator (delta, wye)
     -Rotor (field winding, poles)
     -Brush assemblies
     -Bearings
     -Pulleys
     -End frame assemblies
     -Cooling fans
     -Brushless alternators
   - Voltage regulators
     -External electronic
     -Internal electronic
     -Transistorized
   - Indicators
     -Lights and gauges
     -Volts
     -Amps

**2. Describe and perform diagnostic and testing procedures on charging systems. 40%**

a. Visual inspection
   - Belt tension and alignment
   - Connections and wiring
   - Battery and alternator capacity

b. Charging system testing
   - Battery load test
   - Charging system current and voltage output test
   - Diode tests
   - Circuit and ground resistance

c. Analysis of test results

d. Removal and replacement procedures - precautions

e. Disassembly procedures and testing of components
   - Internal circuitry
   - Stator test
   - Rotor field tests
   - Rectifier diodes test
   - Regulator test

- Bearing condition check
- Slip ring condition check
- Cleaning procedures
- Reassembly procedures

f. Alternator bench testing: output current
- Voltage
- Amperage
- Appropriate testing equipment

g. Diagnosis of charging system problems
- No alternator output
- Low alternator output
- High alternator output
- Noisy alternator
- Excessive water consumption by battery

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Apprenticeship Manitoba

# Truck and Transport Mechanic

## Unit: I5 Body Electrical and Lighting Systems

**Level:** Two

**Duration:** 25 hours

Theory: 20 hours

Practical: 5 hours

**Overview:**

This unit of instruction provides the Truck and Transport Mechanic apprentice with the working knowledge required to diagnose, service and repair body-related electrical, electronics and lighting systems.

**Objectives and Content:** **Percent of Unit Mark (%)**

1. **Describe lighting systems; apply schematic diagrams; diagnose and repair/ replace malfunctions in writing harnesses and related components.** **40%**
   a. Lighting systems and schematic diagrams
      - Exterior lighting
        -Bulb identification
        -Sealed housing headlamp
        -Sealed halogen headlamp
        -Halogen insert bulb
        -Single contact bulb
        -Double contact bulb
        -Headlights and circuits
        -Park lights
        -Brake lights
        -Signal lights
      - Interior lighting
        -Dome lights
        -Dash lights
        -Glove compartment lights
        -Courtesy lights
      - Accessory lighting
        -Trailer lights
        -Roof lights
        -Fog lights

   b. Wiring diagrams and troubleshooting applications
      - Repair manuals and troubleshooting charts
        -Common abbreviations
        -Service manual (illustrations section)
        -Reference section
        -Diagnosis charts (flow chart. troubleshooting, component location)
      - Role of wiring diagrams
        -Wire connections
        -Component locations
      - Common electrical symbols

-Battery
-Capacitor (condenser)
-Coil, solenoid or winding
-Connections and non-connections
-Diode
-Fuse
-Ground
-Lamp
-Relay
-Resistor
-Rheostat
-Solenoid (magnetic switch)
-Switch
-Transistor, PNP
-Transistor, NPN
-Zener diode
-Variable and fixed resistor
-Junction block
-Wiring splices

- Wires and terminals
- Wire types and sizes
  -Solid and stranded
  -Number vs. size
  -American Wire Gauge System
  -Number = conductor diameter
  -Metric size = cross-sectional area = ($mm^2$)
- Wire colour code
  -Solid colour
  -Stripe
  -Spiral stripe
  -Hashmark
  -Marker band
- Cutting and stripping of wires
  -Wire protection devices
  -Tubing
  -Retainer
  -Tie strap
  -Sleeve
  -Clip
  -Boot
  -Clip
  -Vinyl plastic electrical tape
  -Wiring harness
  -Soldering of wires and terminals
  -Use of rosin core
  -Tinning
  -Connector types (eye, tab, spade, hook, butt, mid-line splice, spade, secondary)
  -Crimp type connector and tool
  -Proper wire repair
  -Proper installation of terminal ends from connectors

c. Diagnosis and repair/replacement of malfunctions in wiring harnesses and related components
   - Wiring harness
     -Schematics
     -Connectors
     -Routing
     -Circuit protection
     -Wire repair
     -Fault tracing
   - Diagnosis of electrical system problems
     -Wiring diagrams

- Weather and vapour proof connectors

**2. Describe monitoring and safety devices. 20%**

a. Instrument gauges
   - Instrument voltage regulators
   - Magnetic, thermal and bimetallic gauges

b. Indicators
   - Oil, temperature and fuel gauges
   - Indicator lights

c. Safety devices
   - Seat belt warning
   - Headlight on warning
   - Key-in-switch warning
   - Security alarm

d. Horns
   - Horn
   - Controls
   - Relays
   - Windshield wiper and washers

e. Radio, antenna, clock, lighter, window defoggers

**3. Describe inspection, testing, diagnostics, and repair or replacement of body electrical and electronic components. 40%**

a. Procedures for diagnosing faults
   - Shorts
   - Opens
   - Grounds
   - Resistance

b. Intermittent faults
   - Possible causes: wire chafing, poor connections, connector damage, corroded terminals
   - Visual inspection
   - Damage to sensors, actuators and wiring
   - Connections to sensors, actuators, control modules, ground points

c. Sequential troubleshooting techniques
   - High impedance digital multimeter
   - Circuit damage precautions
   - Electrostatic discharge

d. Wiper and warning system component tests

e. Circuit analysis: manufacturers' troubleshooting charts and wiring diagrams

f. Repair or replacement of body electrical and electronics
   - Removal, repair and replacement procedures for instrument gauges and display systems
   - Safety precautions: electronic devices
   - Proper circuit wiring routing (reduction of magnetic field interference)
   - Radio interference factors

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