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# Working with STEM Digital Library

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# Working with STEM

## Working with STEM Digital Library: Courses

### ENGINEERING

Materials Engineering
Engineering Drawing
Fluid Power
Manufacturing Engineering
Machine and Instrument Engineering
Inspection, Maintenance & Quality Management
Industrial Control

### ELECTRONICS

Electronic Systems
DC Circuits
Electrical Networks
AC Circuits
Magnetism and Electromagnetism
Electrical Engineering
Linear Electronics
Semiconductors
Power Electronics
Digital Electronics
Telecommunications
Microprocessors
Circuit Construction and Testing

Electronic Principles (D3000 Practice)
Semiconductors (D3000 Practice)
Power Electronics (D3000 Practice)
Digital Electronics (D3000 Practice)
Avionics (D3000 Practice)

Electronic Systems (Series 9 Practice)
Electronic Principles (Series 9 Practice)
Linear Electronics (Series 9 Practice)
Semiconductors (Series 9 Practice)
Digital Electronics (Series 9 Practice)
Microprocessors (Series 9 Practice)

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# Engineering

## LIB 3: 01 Materials Engineering

### Materials

- Classification of Materials
- Iron and Steel
- Non-Ferrous Metals
- Ceramic and Sintered Materials
- Composite Materials
- Corrosion
- Polymers
- Lubrication

### Properties of Materials

- Characteristics of Materials

### Structure of Materials

- Structure of Metals
- Materials Testing - Tensile and Impact Testing
- Interpretation of Test Results
- Materials Testing - Hardness and Non-Destructive Testing
- Solutions and Phases
- Microstructure of Metals
- Microstructures of Steel
- Microstructure of Alloys

## LIB 3: 02 Engineering Drawing

### Engineering Drawing

- Drawing Standards
- Basic Geometric Construction
- Types of View
- Co-ordinate Systems
- Dimensions
- Roughness
- Sectional Views
- Drawing Analysis

### Drawing Elements

- Screws and Threaded Components
- Machine Elements
- Tolerance and Fits
- Drilling and Finishes
- Fluid Power Diagrams
- Permanent Connections

## LIB 3: 03 Fluid Power

### Fluid Power

- Basic Fluid Power Engineering
- Fluid Power Concepts
- Pressure and Volume
- Units in Fluid Power
- Fluid Power Formulas
- Types of Pressure
- Calculations of Pressure and Flow Rates
- Hydraulics
- Fluid Power Cylinders
- Basic Control Valves
- Pneumatic Diagrams, Series and Parallel Circuits and Time Delays

- Electropneumatics
- Logic Controls
- Calculations of Hydraulic Power
- Starting and Maintaining Fluid Systems

# LIB 3: 04 Manufacturing Engineering

## Manufacturing Processes

- Manufacturing Processes
- Safety and Protective Measures
- Machine Tools and Terminology
- Primary Metal Shaping Processes
- Cutting Metal
- Turning - Processes and Machines
- Determining Data for Milling
- Grinding - Processes and Machines
- Determining Data for Grinding
- Forces on the Cutting Tool
- Cutting and Angles of Cutting
- Drilling
- Cutting Speed for Drilling
- Bending
- Bending Operation Calculations
- Forming Procedures
- Forming Calculations
- Forming - Material Use and Scrap
- Forging
- Honing
- Erosive Manufacturing Processes
- Spark Erosion
- Hard Metal Cutting
- Finishing Processes
- Environmental Protection
- Reading Machine Diagrams

## Joining

- Joining Procedures
- Screw Connections
- Joining with Glues
- Joining with Soldering
- Joining with Keys and Splines
- Joining with Pins, Bolts and Rivets
- Lapping
- Joining with Threads
- Forces on Threads
- Forces in Threaded Joints
- Formula and Calculation of Tightening Torque

## Welding

- Joining with Welding
- Gas Welding
- Arc Welding
- Gas-Shielded Welding
- Welding Seam Profile and Electrode Requirements

## CNC Programming

- CNC and the Basics of Programming
- CNC Programming for Turning
- CNC Programming for Milling
- Multiple Axis Turning and Milling

## Information Technology

- Process Planning
- Charting Data
- Planning and Organizing Work Processes

## Measurement

- Measuring with a Caliper, Micrometer or Dial Gauge

## LIB 3: 05 Machine and Instrument Engineering

### Engineering Science

- Mechanical Units
- Mass and Volume Flow Rate
- Energy, Work and Efficiency
- Calculating Work, Power and Efficiency
- Transferring Mechanical Energy
- Torque and Power
- Stress-Strain Analysis
- Stress Calculations in Joints
- Manufacturing Facilities
- Material Conversion

### Bearings

- Plain Bearings
- Bearings
- Rolling-Element Bearings
- Bearing Assemblies and Fit
- Calculation of Forces on Bearings
- Seals and Gaskets
- Joining Hubs to Shafts

### Gears

- Simple and Compound Gears
- Gear Drives
- Gear Calculations
- Gear Design Factors
- Clutches
- Traction Drives
- Adjustable Speed Transmission

## LIB 3: 06 Inspection, Maintenance and Quality Management

### Inspection Technology and Quality Management

- Accuracy
- Measuring Lengths
- Calculating Lengths
- Measurement Tolerances
- Tolerance Calculations
- Clearances and Fits
- Calculation of Clearances and Fits
- Quality Management
- Statistical Analysis

### Maintenance

- Maintenance Principles
- Maintenance and Accident Prevention
- Maintenance Documentation
- Maintenance Inspection
- Diagnostics and Troubleshooting
- Mechanical Breakdown
- Fault Repair

## LIB 3: 07 Industrial Control

### Number Systems

- Hexadecimal and Binary Number Systems

### Feedback Control Systems

- On/Off Control Systems
- The Control Loop
- Controller Responses

### Fieldbus Systems

- Introduction to Fieldbus
- The AS Interface
- Profibus DP

### Programmable Logic Control

- Programmable Logic Controllers (PLCs)
- Construction and Function of a PLC
- Sequence Control System
- Components of a Sequence Control System
- PLC Programming
- Converting Logical Circuit to Functional Plan
- GRAFCET Sequence Control Systems
- Using GRAFCET Diagrams
- Basic Structure of a PLC
- Connecting a PLC

### PLC Part Sorting Control

- Creating a STEP 7 Project
- Configure STEP 7 PLC Tags
- Enter a STEP 7 Ladder Program
- Run a STEP 7 Ladder Program
- Flip-Flop Latches
- Counting Parts
- Timers
- Memory Stores
- Analogue Inputs
- Analogue Outputs
- The Rotary Encoder
- Sorting Parts

### PLC Conveyor System Control

- Introduction to PLCs
- Construction and Function of a PLC
- Sequence Control System
- Identifying the Requirements
- Ladder Programming
- Latches
- Latching an Airlock
- Counters
- Counting Parts
- Timers
- Memory Stores
- Analogue Inputs
- Analogue Outputs
- Using GRAFCET Diagrams
- Sorting Parts 1
- Sorting Parts 2
- Create a STEP 7 Project (Siemens Panel)
- Configure STEP 7 PLC Tags (Siemens Panel)
- Enter a STEP 7 Ladder Program (Siemens Panel)
- Run a STEP 7 Ladder Program (Siemens Panel)
- Flip-Flop Latches (Siemens Panel)
- Counting Parts (Siemens Panel)
- Timers (Siemens Panel)
- Memory Stores (Siemens Panel)
- Analogue Inputs (Siemens Panel)
- Analogue Outputs (Siemens Panel)
- Sorting Parts 1 (Siemens Panel)
- Sorting Parts 2 (Siemens Panel)

## LIB 3: 08 Electronic Systems

### Signal Processing

- Systems and Sub-Systems
- Electronic Systems
- Inputs, Outputs and Processes
- Measurement of Non-Electrical Quantities
- Types of Circuit Diagrams
- Analogue Signal Processing
- Digital Signal Processing

### Components

- Alternative Components
- Data and Selection
- System Components
- Characteristics of Non-Linear Components
- Problem Solving - Identify Electronic Components
- Problem Solving - Recognize and Select Components

### Alarm Systems

- Components of Intruder and Fire Alarms
- Installing Intruder and Fire Alarms

### Closed Loop Control

- An Example On/Off Control System
- Automatic Temperature Control
- RC Circuit Responses

### Energy and Power

- Small Energy Sources
- Extending System Life

### Fault Finding Electronic Systems

- Fault Location Techniques
- Faults and Fault Finding Aids
- Electronic Systems Maintenance
- Fault Conditions
- Problem Solving - Testing and Fault Finding on Electronic Components

## LIB 3: 09 DC Circuits

### Resistance

- Relationship between Voltage, Current and Resistance
- Resistance and Conductance
- Resistance and Conductance Reciprocal Calculations
- Resistors
- Electrical Power and Resistor Color Coding
- Color Code and Tolerance
- Calculating Resistance Color Code Values and Tolerance
- Investigating Whether Resistors are in Tolerance
- Measuring Resistance
- Resistance Characteristics
- Investigating a Characteristics Graph for a Resistive Component
- Gradient of a Linear Voltage-Current Graphs
- Applications of Ohm's Law
- Calculating the Resistor Value for an LED Lamp Circuit
- Changing the Resistance in an LED Circuit
- Resistor Characteristics and Applications
- Non-Linear Resistances

### Voltage and Current

- Electrical Principles
- Basic Electrical Quantities in Circuits
- Units, Multiples and Sub-Multiples
- Potential Difference and Voltage
- The Basic DC Circuit
- Introduction to Electric Current
- Measurement in Circuits
- Measuring Voltage
- Measuring Current in a Circuit (board)
- Handling Voltage Calculations
- Simple Circuits
- Circuit Diagrams
- Electric Current and Safety

## Capacitor Circuits

- Capacitors
- Capacitance of Capacitors
- Interconnection of Capacitors
- Calculating Total Capacitance
- Capacitors in Series and Parallel
- Charging and Discharging a Capacitor
- Capacitor Discharge Curve
- Capacitor Timing Circuits
- Resistance and the Time Constant

## Inductor Circuits

- Inductors - Graphs and Equations

## Electrical Energy and Power

- Electrical Power
- Calculation of Electrical Power
- Calculating Electrical Power for a Load

# LIB 3: 10 Electrical Networks

## Series and Parallel Lamps

- Series Circuits
- Parallel Circuits

## Series and Parallel Resistors

- Resistors in Series
- Calculation of Resistors in Series
- Series Circuit Calculations
- Parallel Resistor Circuits
- Resistors in Parallel
- Calculation of Resistors in Parallel
- Parallel Circuit Calculations
- Series and Parallel Resistor Combinations
- Series and Parallel Equivalent Resistance
- Characteristics of Series and Parallel Connections
- Working with Series and Parallel Characteristic Curves
- Mathematical Approach to Series and Parallel Circuit Simplification

## Voltage Divider Principle

- The Voltage Divider Principle
- Voltage Divider Operation

## Internal Resistance

- Internal Resistance
- Internal Resistance of Power Sources

## Kirchhoff's Laws

- Kirchhoff's First Law
- Current Behaviour at a Node
- Calculations using Kirchhoff's First Law
- Kirchhoff's Second Law
- Voltages in a DC Network
- Calculations using Kirchhoff's Second Law

## Thevenin's Theorem

- Thevenin's Equivalent Circuits
- Thevenin's Equations

## Superposition Principle

- The Superposition Principle
- Applying the Superposition Principle

## Measuring Instruments

- Absolute and Relative Measurement Errors
- Handling Measurement Errors
- Extending the Range of a Voltmeter
- Calculating the Extension of the Range of a Voltmeter
- Measuring Current and Extending Ammeter Range
- Calculating the Extension the Range of an Ammeter



## LIB 3: 11 AC Circuits

### AC Principles

- Introduction to Alternating Current
- Alternating Current Equations
- Effective Values of Alternating Voltages and Currents
- Calculating the Effective Values of Alternating Voltages and Currents
- Measuring with an Oscilloscope
- Amplitude and Timebase Settings of an Oscilloscope
- Period and Frequency
- Peak, Peak-to-Peak and RMS Values

### Inductor Circuits

- Inductors in AC Circuits
- Calculations on Inductive Reactance with Graphical Representation
- RL Circuits
- Graphical Representations and Equations of RL Circuits

### RLC Circuits

- RLC Circuits
- Graphical Representation of Equations of RLC Circuits
- Phase Difference and Power
- Graphical Representation of Phase Difference and Power
- Power in RLC Circuits
- Calculation Power in RLC Circuits
- LC Oscillator Circuit
- Calculating the Resonant Frequency of an LC Oscillator Circuit

### Capacitor Circuits

- Capacitors in AC Circuits
- Calculations on Capacitive Reactance with Graphical Representation
- RC Circuits
- Graphical Representations and Equations of RC Circuits

## LIB 3: 12 Magnetism and Electromagnetism

### Magnetic and Electromagnetic Principles

- Magnetic Principles
- Reed Switch and Relay
- Electromagnetism
- Hall Effect Sensor
- Field Strength of an Electromagnet
- Field Shape and Direction for an Electromagnet
- Electromagnetic Induction
- Electromagnetic Induction and the Solenoid
- Self Inductance of Inductors
- Inductors - Graphs and Equations
- Magnetic Flux and Flux Density
- Magnetic Flux and Flux Density Calculations

### Transformers

- Transformers
- Transformer Voltages and Turns Ratio
- Transformer Calculations
- Transformer Power and Efficiency

### DC Motor

- The DC Motor
- DC Motor Operation
- Characteristics of the DC Motor
- DC Motor-Generator

### Fault Finding Electromagnetic Devices

- Fault Finding Electromagnetic Devices W1
- Fault Finding Electromagnetic Devices W2
- Fault Finding Electromagnetic Devices W3
- Fault Finding Electromagnetic Devices W4

## LIB 3: 13 Electrical Engineering

### Electrical Safety and Accident Prevention

- Dangers of Electric Current for Humans
- Safeguards Against Electric Shock
- Effect of Electric Current on the Human Body
- Dealing with a Victim of an Electric Shock
- Earthing Systems
- TN Earthing Systems
- Designing for Safety
- Cables and Wires
- Voltage Drop in Cables and Wires
- Minimum Safe Cross-Sectional Area of Wires
- Circuit Breakers
- Consumer Units
- Re-Testing to Electrical Standards
- Ingress Protection and IP Codes

### Electrical Connections in Buildings

- Electrical Installation in Residential Buildings
- Components of an Electrical Installation
- Light and Lighting
- Planning Lighting Systems
- Technology in the Home - Heating
- Technology in the Home - Cooling
- Technical Building Management System
- Bus System

### Generating and Distributing Electric Energy

- Production, Transmission and Distribution of Electrical Energy
- Energy Distribution Calculations

## LIB 3: 14 Linear Electronics

### Analogue Circuits

- Types of Analogue Circuits

### Operational Amplifier Circuits

- Operational Amplifiers
- Comparator
- Inverting and Non-Inverting Operational Amplifier Circuits
- Investigating Inverting Op-amp Circuits
- Investigating Non-Inverting Op-amp Circuits
- Operational Amplifier with AC Input (Simulator)
- High Frequency Performance of an Operational Amplifier

### Analogue ICs

- IC Sensors
- The 555 Oscillator/Timer
- Analogue Switches
- Switched Capacitor Filters

### Power Supplies

- A DC Power Supply
- Voltage Stabilizers
- Voltage Regulators

### Fault Finding Linear Electronic Circuits

- Planning a Fault Location Strategy
- Fault Finding Operational Amplifier Circuits W1
- Fault Finding Operational Amplifier Circuits W2
- Fault Finding Operational Amplifier Circuits W3
- Fault Finding Operational Amplifier Circuits W4
- Fault Finding Linear Electronic Circuits W1
- Fault Finding Linear Electronic Circuits W2
- Fault Finding Linear Electronic Circuits W3
- Fault Finding Linear Electronic Circuits W4

## LIB 3: 15 Semiconductors

### Diodes

- Diode Operation
- Diode Characteristics
- Diode Rectifiers
- Rectifier Circuits
- Simple Rectifier Circuit
- Diode Rectifier Calculations
- Light Emitting Diodes
- Zener Diodes
- Voltage Stabilization with Zener Diodes

### Transistors

- Transistors
- Bipolar Transistor Characteristics
- Analyzing Transistor Characteristics
- Transistor as a Switch
- PNP Transistor Switch
- Transistor Characteristics and Circuit Calculations
- Comparison of Electronic and Electromechanical Switches
- The Darlington Pair and the FET
- Field Effect Transistor Operation
- Field Effect Transistor Amplifier

### Transistor Amplifiers

- Transistor Amplifier - Voltage Amplification
- The Transistor as a Voltage Amplifier
- Effects of Feedback in a Transistor Amplifier Circuit
- Transistor Amplifier - Effect of Bias
- The Emitter Follower
- Gain, Loss and Noise
- Classes of Transistor Amplifiers
- Class A Transistor Amplifier
- Biasing a Transistor Amplifier
- Class B and AB Transistor Amplifiers
- Class C Transistor Amplifier

### SCRs

- Thyristor Operation
- Thyristor
- Characteristics of Thyristors

### Display Devices

- A 7-Segment Display
- 7-Segment Display and Decoder
- Optoelectronic Display Devices

### Fault Finding Semiconductor Circuits

- Test Data Records
- Fault Finding Semiconductor Circuits W1
- Fault Finding Semiconductor Circuits W2
- Fault Finding Semiconductor Circuits W3
- Fault Finding Semiconductor Circuits W4
- Fault Finding Transistor Amplifiers W1
- Fault Finding Transistor Amplifiers W2
- Fault Finding Transistor Amplifiers W3
- Fault Finding Transistor Amplifiers W4

## LIB 3: 16 Power Electronics

### Three-phase AC

- Generation of Three-phase AC
- Representation of Three-phase AC
- Star Connection
- Star Calculations
- Delta Connection
- Delta Calculations

### Motors and Motor Control

- Electric Motors
- The Induction Motor
- Characteristics of an Induction Motor
- Motor Starting and Speed Control
- Speed Control of Induction Motors
- The Single-phase AC Motor
- Starting a Single-phase AC Motor
- Connecting a Motor
- Motor Drive Connection Components

### Energy and Power

- Efficiency of Electric Motors
- Efficiency Formulas for Electric Motors

### Contactors

- Construction of a Contactor
- Selection of Contactors
- Controlling Contactors
- Latching in Contactor Circuits
- Current Flow in Latching Circuits

### Motor Protection

- Motor Installations and Safety
- Interlock Systems
- Motor Protection
- Motor Drive Protection Circuit

### Frequency Converters

- Construction and Function of Frequency Converters
- Commissioning of Frequency Converters
- Frequency Converter Parameters
- Connecting a Frequency Converter
- EMC
- Frequency Filters

## LIB 3: 17 Digital Electronics

### Number Systems

- Conversions Between Number Systems
- Calculations in Binary

### Interfacing

- Industry Standards
- Interfacing in Digital Circuits
- Tri-State Devices and Data Access
- Tri-State Logic
- Bi-directional Line Drivers

### Signal Processing

- Digital Signal Processing
- Sensors
- Physical Environment to Electrical Transformation

### Combinational Logic

- Basic Logic Functions and Their Algebra
- Logic Gates
- TTL Logic Gate Input and Output Characteristics
- TTL Input and Output Characteristics
- Characteristics of a Schmitt Inverter Gate
- Characteristics of the EX-OR and EX-NOR Circuit
- Logic Families
- Boolean Algebra
- Combinational Logic
- Circuits Involving Combinational Logic
- Building EXOR Gates from Other Gates
- Boolean Algebra and De Morgan's Theorems
- Equivalent Logic Circuits
- Karnaugh Maps

## Sequential Logic

- Integrated Circuit Memory
- Bistable Devices
- The S-R Latch
- The S-R Latch Constructed From NAND Gates
- Characteristics of a D-Type Flip-Flop
- D-Type Flip-Flop
- Characteristics of a J-K Flip-Flop
- The J-K Flip-Flop
- Binary Counters
- Counting with Bistables (Simulator)
- Asynchronous Counters
- Synchronous Counters
- Shift Registers
- Characteristics of a D-Type 2-bit Shift Register

## Digital Systems

- Types of Digital Circuits
- Binary Counters and 7-Segment Displays
- Binary-Coded Decimal Counters
- Encoders and Decoders
- Encoder Operation
- Multiplexers and Demultiplexers
- Multiplexer Operation
- Signal Converters
- Digital to Analogue Conversion
- Analogue to Digital Conversion
- Testing Digital Systems
- Characteristics of an Analogue Comparator

## Digital Systems (continued)

- Ramp Generator
- Glitches in Digital Systems
- Decoder Operation
- Encoder-Decoder System
- Demultiplexer Operation
- Multiplexer-Demultiplexer System

## Fault Finding Digital Circuits

- Calculating Expected Operating Conditions
- Fault Finding Aids
- Fault-Finding Aids and Reporting
- Testing a Fault Logic Circuit
- Signal Tracing Techniques
- Test Instruments
- Fault Finding A/D and D/A Circuits W1
- Fault Finding A/D and D/A Circuits W2
- Fault Finding A/D and D/A Circuits W3
- Fault Finding A/D and D/A Circuits W4
- Fault Finding Encoding/Decoding Circuits W1
- Fault Finding Encoding/Decoding Circuits W2
- Fault Finding Encoding/Decoding Circuits W3
- Fault Finding Encoding/Decoding Circuits W4
- Fault Finding Multiplexing/Demultiplexing Circuits W1
- Fault Finding Multiplexing/Demultiplexing Circuits W2
- Fault Finding Multiplexing/Demultiplexing Circuits W3
- Fault Finding Multiplexing/Demultiplexing Circuits W4
- Faults in Shift Register Circuits
- Faults in Ring Counter Circuits

# LIB 3: 18 Telecommunications

## Electronic Communication Principles

- Electronic Communication Systems
- AM Transmission
- Optical Transmission
- Simplex and Duplex Transmission
- Phase Locked Loops

## Digital Data Transmission

- Digital Data Transmission
- Transmission Protocols
- Handshaking and Flow Control

## Antennas

- Installing Antenna and Broadband Connections
- Antenna and Broadband Options

## Fault Finding Telecommunication Circuits

- Fault Finding Telecommunication Circuits W1
- Fault Finding Telecommunication Circuits W2
- Fault Finding Telecommunication Circuits W3
- Fault Finding Telecommunication Circuits W4

## LIB 3: 19 Microprocessors

### Microprocessor System Applications

- Microprocessor System Applications

### Program Development

- Entering and Running a Program
- Designing a Program

### Architecture and Operation of a Microprocessor

- Architecture
- Principles of Operation

### Number Systems, Instructions and Subroutines

- Number Systems
- Instruction Groups
- Subroutines and the Stack

### Developing PIC Programs

- Debugging Programs
- Controlling a Motor
- Using Feedback
- Full Washing Machine Sequence

### Memory

- Embedded Computers and RAM/Flash Memory

## LIB 3: 20 Circuit Construction and Testing

### Safety and Accident Prevention

- Safety Awareness
- Safe Working Practices
- Workplace Hazards
- Risk Assessment of Electrical Dangers

### Lamp Circuit

- Simple Lamp Circuit
- Lamp Circuit

### Simulators

- Computer-Based Design and Testing

### Polarity Tester

- Building and Testing a Polarity Tester
- Building and Testing a Polarity Tester (Simulator)

### Diagnosing Fault Conditions

- Fault Rectification

### LED Lamp Circuit

- Building an LED Lamp Circuit (Simulator)
- Building an LED Lamp Circuit
- Testing a Faulty LED Lamp Circuit (Board)

### Automatic Light Circuit

- Building and Testing an Automatic Light Circuit
- Building and Testing an Automatic Light Circuit (Simulator)
- Testing a Faulty Automatic Light Circuit
- Testing a Faulty Automatic Light Circuit (320 Board)

### Building on Breadboard

- Breadboarding
- Planning an Automatic Light Circuit on Breadboard
- Building the Automatic Light Circuit on Breadboard

## Improved Automatic Light Circuit

- Building and Testing an Improved Automatic Light Circuit
- Building and Testing an Improved Automatic Light Circuit (Board)
- Testing a Faulty Improved Automatic Light Circuit (320 Board)

## Freezer Temperature Warning Circuit

- Building the Freezer Temperature Warning Circuit on Breadboard

## Intruder Alarm

- Intruder Alarm Circuit
- Intruder Alarm Circuit (Simulator)
- Simulated Latched Buzzer Circuit (Simulator)
- Latched Buzzer Circuit

## Building on Stripboard

- Building Circuits on Stripboard
- Planning an Anti-Theft Device
- Building and Testing the Anti-Theft Device

## Flashing Doorbell Circuit

- Flashing Doorbell Circuit
- Using an Oscilloscope (Board)
- Building a Flashing Doorbell Circuit (Simulator)
- Building a Flashing Doorbell Circuit
- Testing a Faulty Flashing Doorbell Circuit 1 (Board)
- Testing a Faulty Flashing Doorbell Circuit 2 (Board)

## Building Circuits on Printed Circuit Boards

- Building Circuits on PCB
- Constructing the Continuity Tester on PCB

## Elevator Door Controller

- The Elevator Door Controller
- The Elevator Door Controller (Simulator)
- Testing a Faulty Elevator Door Controller 1 (Board)
- Testing a Faulty Elevator Door Controller 2 (Board)

## AC and DC Converter

- AC to DC Concepts and Principles
- Circuit Breakers and Fuses
- A Simple AC to DC Converter

## Baby Alarm

- Building a Baby Alarm
- Building a Baby Alarm (Board)
- Testing a Faulty Baby Alarm 1 (Board)
- Testing a Faulty Baby Alarm 2 (Board)

## Road Crossing Controller

- Road Crossing Controller

## Electronic Problem Solving

- Problem Solving - Produce an Electronic Circuit Diagram (Simulator)
- Problem Solving - Plan, Construct and Test an Electronic Circuit
- Problem Solving - Construct an Electronic Circuit

## LIB 3: 21 Electronic Principles (D3000 Practice)

### DC Principles

- The Basic DC Circuit - Exercise 1.1

### Resistance

- Ohm's Law - Exercise 2.1
- Resistor Color Coding for Low Power Resistors - Exercise 4.1
- Resistor Color Coding for Low Power Resistors - Worksheet 2
- Resistor Color Coding for Low Power Resistors - Worksheet 3
- Variable Resistor Characteristics and Applications - Exercise 8.1
- Variable Resistor Characteristics and Applications - Exercise 8.2
- Controlling a Lamp with a Variable Resistor - Exercise 9.1
- Controlling a Lamp with a Variable Resistor - Worksheet 7
- Controlling a Lamp with a Variable Resistor - Worksheet 8
- Resistance Measurement using a Wheatstone Bridge - Exercise 11.1
- Resistance Measurement using a Wheatstone Bridge - Worksheet 11
- Resistance Measurement using a Wheatstone Bridge - Worksheet 12

### Electrical Networks

- Resistors in Series (Circuit Board)
- Resistors Connected in Series - Exercise 5.1
- Voltage Dividing with Series Resistors - Exercise 5.2
- Parallel Resistor Circuits (Circuit Board)
- Resistors Connected in Parallel - Exercise 6.1
- Voltage and Current Relationships for Parallel Connected Circuits - Exercise 6.2
- Series-Parallel Connected Circuits - Exercise 7.1
- Series-Parallel Connected Circuits - Worksheet 4
- Series-Parallel Connected Circuits - Worksheet 5
- Series-Parallel Connected Circuits - Worksheet 6
- Series-Parallel Circuit Exercise - Exercise 10.1
- Series-Parallel Circuit Exercise - Worksheet 9
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- Thevenin's Equivalent Circuits (Circuit Board)

### Electrical Energy and Power

- Power in a Resistor - Exercise 3.1
- Power in a Resistor - Worksheet 1
- Power Dissipated in a Lamp Circuit - Exercise 9.2

### AC Principles

- Sinusoidal Alternating Waveforms - Exercise 1.1
- Sinusoidal Alternating Waveforms Peak and RMS Values - Exercise 1.2
- Alternating Supply with Pure Resistance Loading - Exercise 2.1
- Alternating Supply with Pure Resistance Loading - Worksheet 1
- Voltage and Current Phase Relationships - Exercise 2.2
- Resistances in Series - Exercise 2.3
- Resistances in Parallel - Exercise 2.4
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### Capacitor Circuits

- AC Supply with Pure Capacitive Loading - Exercise 4.1
- AC Supply with Pure Capacitive Loading - Worksheet 2
- Variation of Capacitive Reactance with Capacitance - Exercise 4.2
- Capacitors in Parallel on an AC Supply - Exercise 4.3
- Capacitors in Series on an AC Supply - Exercise 4.4
- Capacitor AC Voltage Divider Circuit - Exercise 4.5
- Resistance-Capacitance Circuits on AC Supplies - Series - Exercise 6.1
- Resistance-Capacitance Circuits on AC Supplies - Parallel - Exercise 6.2

### Inductor Circuits

- Inductance with Square Wave and Sinusoidal Voltage Input - Exercise 3.2
- AC Supply with Pure Inductive Loading - Exercise 5.1
- AC Supply with Pure Inductive Loading - Worksheet 3
- AC Supply with Pure Inductive Loading - Worksheet 4
- Inductors in Series on an AC Supply - Exercise 5.2
- Inductors in Parallel on an AC Supply - Exercise 5.3
- Voltage Dividing with Inductors in Series on an AC Supply - Exercise 5.4
- Resistance-Inductance Circuits on AC Supplies - Series - Exercise 7.1
- Resistance - Inductance Parallel Circuits on an AC Supply - Exercise 7.2
- Resistance-Inductance Circuits on AC Supplies - Worksheet 5
- Resistance-Inductance Circuits on AC Supplies - Worksheet 6
- Resistance-Inductance Filters - Exercise 9.2



## RLC Circuits

- Capacitance and Inductance fed from Square and Sinusoidal Inputs - Exercise 3.1
- Resistance-Inductance-Capacitance Circuits on AC Supplies - Exercise 8.1
- Inductance-Capacitance Parallel Circuit on an AC Supply - Exercise 8.2
- Inductance-Capacitance Parallel Circuit on an AC Supply - Exercise 8.3
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- RLC Circuits on AC Supplies - Worksheet 8
- RLC Circuits on AC Supplies - Worksheet 9
- Resistance-Inductance and Resistance-Capacitance Filter Circuits - Exercise 9.1
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## Transformer

- The Transformer - Exercise 10.1
- Transformer Characteristics on Load - Exercise 10.2
- Application of Transformers to Impedance Matching - Exercise 10.3
- The Transformer - Worksheet 11
- The Transformer - Worksheet 12
- Transformer Isolation - Exercise 11.1
- Transformer Isolation in a Resistor Network - Exercise 11.2

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## Diodes

- Diode Forward Characteristic (Board) - Exercise 1.1
- Diode Reverse Characteristic (Board) - Exercise 1.2
- Testing a Diode (Board) - Exercise 1.3
- P-N Junction Diode - Worksheet 1
- P-N Junction Diode - Worksheet 2
- Half-Wave Rectifier - Exercise 2.1
- Reservoir Capacitor - Exercise 2.2
- Negative Power Supply - Exercise 2.3
- Half-Wave Rectifier - Worksheet 3
- Bridge Rectifier - Exercise 3.1
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- Zener Diode Stabilizer Currents - Exercise 4.2
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## Transistors

- Bipolar Transistor Characteristics (Circuit Board)
- Transistor Characteristics - Current Gain - Exercise 5.1
- Transistor Output Characteristic - Exercise 5.2
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- Transistor Characteristics - Worksheet 6
- The Transistor as a Simple Switch - Exercise 10.1
- Regenerative Switch - Exercise 10.2
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- Transistor Amplifier - Voltage Amplification - Exercise 6.1
- Need for Bias - Exercise 6.2
- Stage Gain and Input Impedance - Exercise 6.3
- Collector Feedback Stabilization - Exercise 7.1
- Base Potential Divider Stabilized Amplifier - Exercise 7.2
- Emitter Decoupling Capacitor - Exercise 7.3
- Fault Diagnosis - Preparatory Investigation 1
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- Common Collector Amplifier (Emitter Follower) - Exercise 8.1
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### Three-Phase Supplies

- The Three-Phase Supply - Exercise 1.1
- 6-Wire, 3-Wire and 4-Wire Connections, Delta/Delta Connection - Exercise 2.1
- 3-Wire Connection of a 3-Phase Supply (Delta/Delta Connection) - Exercise 2.2
- 6-Wire, 3-Wire and 4-Wire Connections, Delta/Delta Connection - Worksheet 1
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- Delta/Wye Connection - Exercise 3.1
- Delta/Wye Connection - Worksheet 3
- Wye/Wye Connection - Balanced - Exercise 4.1
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- Wye/Wye Connection - Worksheet 4
- Wye/Delta Connection - Exercise 5.1
- Wye/Delta System - Phase - Exercise 5.2
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### AC Motors

- AC Motor Principles, and the Three-Phase Synchronous Motor - Exercise 6.1
- Wye Connection of a 3-Phase Synchronous Motor to Wye Supply - Exercise 6.2
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- AC Motor Principles, and the Three-Phase Synchronous Motor - Worksheet 6
- Single-Phase Synchronous Motor - Exercise 7.1
- Capacitor Offset - Exercise 7.2
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- Power Factor Correction - Exercise 8.1
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- Other AC Motors - Exercise 9.1

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- Negative DC Supply - Exercise 10.2
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- Three-Phase Rectifiers - Worksheet 10
- Three-Phase Inverter and Over-Current Protection - Exercise 11.1
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## LIB 3: 24 Digital Electronics (D3000 Practice)

### Number Systems

- Number Systems - Measurement of Voltage Levels - Exercise 1.1
- Number Systems - Worksheet 1
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### Combinational Logic

- Series and Parallel Connection of Switches - Exercise 2.1
- Switch Logic - Worksheet 3
- Diode AND and OR Gate Characteristics - Exercise 3.1
- Diode Logic - Worksheet 4
- Transistor Inverter Characteristics - Exercise 4.1
- Diode-Transistor Logic Gate Characteristics - Exercise 4.2
- Diode-Transistor Logic (DTL) - Worksheet 5
- Diode-Transistor Logic (DTL) - Worksheet 6
- TTL Logic Truth Tables - Exercise 5.2
- Transistor-Transistor Logic (TTL) Gates - Worksheet 7
- Transistor-Transistor Logic (TTL) Gates - Worksheet 8
- Equivalent Logic Circuits 1 - Exercise 6.1
- Equivalent Logic Circuits 2 - Exercise 6.2
- Equivalent Logic Circuits 3 - Exercise 6.3
- Karnaugh Maps - Exercise 7.1
- Three-Variable Karnaugh Maps - Exercise 7.2
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- Characteristics of a Schmitt Inverter Gate - Exercise 9.1
- Characteristics of the Wired-AND Circuit - Exercise 10.1
- Characteristics of the Wired-NOR Circuit - Exercise 10.2
- Open Collector Gates - Worksheet 9
- Open Collector Gates - Worksheet 10
- Characteristics of the EX-OR and EX-NOR Circuit - Exercise 1.1
- Characteristics of the Half Adder Circuit - Exercise 1.2
- EX-OR and EX-NOR Gates - Worksheet 1
- EX-OR and EX-NOR Gates - Worksheet 2
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### Interfacing

- TTL Logic Gate Input and Output Characteristics - Exercise 5.1
- TTL Input and Output Characteristics - Exercise 8.1
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### Sequential Logic

- Characteristics of a NAND Gate S-R Latch - Exercise 1.1
- Characteristics of an S-R Latch IC - Exercise 1.2
- The S-R Latch - Worksheet 1
- The S-R Latch - Worksheet 2
- The S-R Latch - Worksheet 3
- The S-R Latch - Worksheet 4
- Characteristics of a D-Type Flip-Flop - Exercise 2.1
- Characteristics of a D-Type with D Connected to Q - Exercise 2.2
- The D-Type Flip-Flop - Worksheet 5
- The D-Type Flip-Flop - Worksheet 6
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- The D-Type Flip-Flop - Worksheet 8
- Characteristics of a J-K Flip-Flop - Exercise 3.1
- Characteristics of a J-K Flip-Flop Connected as a D-Type - Exercise 3.2
- Characteristics of a J-K Flip-Flop Connected as a T-Type - Exercise 3.3
- The J-K Flip-Flop - Worksheet 9
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- Characteristics of a D-Type 2-bit Shift Register - Exercise 4.1
- Characteristics of a J-K 4-bit Shift Register - Exercise 4.2
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- Characteristics of a J-K 4-bit Binary Counter - Exercise 5.2
- Characteristics of a Binary Up Counter with Reduced Count - Exercise 5.3
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- Binary Counters - Worksheet 12

## Digital Systems

- Characteristics of a 4-2 Line Encoder Circuit - Exercise 2.1
- Characteristics of a 2-4 Line Decoder Circuit - Exercise 2.2
- Encoder and Decoder Circuits - Worksheet 5
- Encoder and Decoder Circuits - Worksheet 6
- Encoder and Decoder Circuits - Worksheet 7
- Characteristics of a 4-input Multiplexer Circuit - Exercise 3.1
- Characteristics of a 1 to 1-of-4-line Demultiplexer Circuit - Exercise 3.2
- Characteristics of a Multiplexer/Demultiplexer Circuit - Exercise 3.3
- Multiplexer and Demultiplexer Circuits - Worksheet 8
- Multiplexer and Demultiplexer Circuits - Worksheet 9
- Characteristics of a 4-input Priority Encoder Circuit - Exercise 4.1
- Priority Encoder Circuits - Worksheet 10
- Priority Encoder Circuits - Worksheet 11
- 2-bit Equal-Input Magnitude Comparator Circuit - Exercise 5.1
- Characteristics of a Single-Bit Magnitude Comparator Circuit - Exercise 5.2
- Characteristics of a 4-bit Magnitude Comparator IC - Exercise 5.3
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- Full Adder Circuits - Exercise 6.1
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- Characteristics of a Three State Logic Circuit - Exercise 7.1
- Characteristics of a 2-1 Multiplexer Using Three State Logic - Exercise 7.2
- Characteristics of a Three State Logic Bi-Directional Switch - Exercise 7.3
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- Characteristics of an Analogue Switch IC (211) - Exercise 1.1
- Characteristics of an S - R Latch IC (74LS00) - Exercise 1.2
- Characteristics of an Astable IC (4047) - Exercise 1.3
- Characteristics of a Monostable IC (74LS123) - Exercise 1.4
- Characteristics of an Analogue Switch, S - R Bistable System - Exercise 1.5
- The Analogue Switch and Multivibrator IC Circuits - Worksheet 1
- The Analogue Switch and Multivibrator IC Circuits - Worksheet 2
- The Analogue Switch and Multivibrator IC Circuits - Worksheet 3
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- Binary/BCD Counters and 7-Segment Decoder/Driver/Displays - Exercise 2.1
- BCD UP/DOWN Counters and 7-Segment Decoder/Driver/Displays - Exercise 2.2
- Binary/BCD Counters, and 7-Segment Decoder/Driver/Displays - Worksheet 6
- Binary/BCD Counters, and 7-Segment Decoder/Driver/Displays - Worksheet 7
- Binary/BCD Counters, and 7-Segment Decoder/Driver/Displays - Worksheet 8
- Binary/BCD Counters, and 7-Segment Decoder/Driver/Displays - Worksheet 9
- Characteristics of an Analogue Comparator IC (311) - Exercise 3.1
- Characteristics of an Analogue Integrator IC (3140) - Exercise 3.2
- Triangular Waveform Generation - Exercise 3.3
- Signal Converters - Exercise 4.1
- Characteristics of an Incremental A-D Converter System - Exercise 4.2
- Waveform Generator and Digital Voltmeter Systems - Exercise 5.1
- Characteristics of a Frequency Counter System - Exercise 5.2
- Characteristics of a Timer/Counter System - Exercise 5.3
- Characteristics of a Triangular Waveform Generator System - Exercise 5.4
- The Analogue Comparator and Analogue Integrator - Worksheet 10
- D-A Converter IC and an A-D Converter Circuit - Worksheet 11
- Fault Diagnosis - Triangle Waveform Generator Circuit - Worksheet 12

## LIB3: 25 Avionics (D3000 Practice)

### Single Engine Aircraft Battery Power Electrical System

- The Battery and Associated Control Circuitry - Exercise 1.1
- The Starting Motor and Associated Control Circuitry - Exercise 1.2
- The Ammeter - Exercise 1.3
- Single Engine Aircraft Electrical Systems - Worksheet W1
- Single Engine Aircraft Electrical Systems - Worksheet W2
- Power Distribution - Exercise 2.1
- Electronics/Avionics Busbar Isolation - Exercise 2.2
- Single Engine Power Distribution Systems - Worksheet W3
- Single Engine Power Distribution Systems - Worksheet W4

### Single Engine Aircraft Power Generation Electrical System

- The Alternator - Exercise 3.1
- Single Engine Auxiliary Power Supply Systems - Exercise 3.2
- Single Engine Power Supply Systems - Worksheet W5
- Single Engine Power Supply Systems - Worksheet W6
- A Typical Alternator System From 1963 To 1968/69 - Exercise 4.1
- A Typical 1979 Alternator System - Exercise 4.2
- Cessna Single Engine Electrical Power Systems - Worksheet W7
- Cessna Single Engine Electrical Power Systems - Worksheet W8

### Single Engine Aircraft Power Consuming Electrical Circuits

- Early Internal Lighting Systems - Exercise 5.1
- Transistor Control of Panel Lights - Exercise 5.2
- Single Engine Internal Lighting Systems - Worksheet W9
- Steady State Navigation Lights - Exercise 6.1
- Steady or Flashing Navigation Lights - Exercise 6.2
- Landing, Taxi and Anti-Collision Lights - Exercise 6.3
- Single Engine External Lighting Systems - Worksheet W10
- Single Engine External Lighting Systems - Worksheet W11
- Hydraulic Landing Gear Control and Indication Systems - Exercise 7.1
- Electrical Landing Gear Control and Indication Systems - Exercise 7.2
- Landing Gear Control and Indication Systems - Worksheet W12
- Flap Control Systems - Exercise 8.1
- Flap Control Systems - Worksheet W13

### Single Engine Aircraft Stall Warning System Instruments

- A Stall Warning System using a Vane Switch - Exercise 1.1
- Vane Switch Stall Warning System, with Angle of Attack Indication - Exercise 1.2
- Single Engine Aircraft Stall Warning Systems - Worksheet W1

## Single Engine Aircraft Take-Off Warning System Instruments

- Basic Logic Gates - Exercise 2.1
- Take-Off Warning System - Exercise 2.2
- Take-Off Warning System - Exercise 3.1
- Take-Off Warning Systems - Worksheet W2
- Take-Off Warning Systems - Worksheet W3

## Single Engine Aircraft Temperature Measurement Instruments

- Nickel Wire Temp Sensor - Wheatstone Bridge and Analog Display - Exercise 4.1
- Nickel Wire Temp Sensor - Wheatstone Bridge and Digital Display - Exercise 4.2
- Nickel Wire Temp Sensor - Ratiometer and Analog Display - Exercise 4.3
- Nickel Wire Sensor Temperature Systems - Worksheet W4
- Nickel Wire Sensor Temperature Systems - Worksheet W5
- Thermocouple Temperature Sensor - Amplifier and Analog Display - Exercise 5.1
- Thermocouple Temperature Sensor - Amplifier and Digital Display - Exercise 5.2
- Thermocouple Sensor Temperature Systems - Worksheet W6
- Thermocouple Sensor Temperature Systems - Worksheet W7

## Single Engine Aircraft Fuel Quantity Measurement Instruments

- Fuel Measurement Using a Capacitor Bridge - Exercise 6.1
- Fuel Measurement Using a Capacitor Bridge, Displayed Digitally - Exercise 6.2
- Fuel Quantity Measurement Using a Capacitor Bridge - Worksheet W8

## Single Engine Aircraft Fuel Flow Measurement Instruments

- Fuel Measurement Using a Tank Resistor - Exercise 7.1
- Optical Rotor Fuel Flow Measurement and Digital Display - Exercise 7.2
- Fuel Quantity and Fuel Flow Measurement - Worksheet W9
- Fuel Quantity and Fuel Flow Measurement - Worksheet W10

## LIB 3: 26 Electronic Systems (Series 9 Practice)

### Components

- Light Dependent Resistor - LDR
- Thermistor
- Applying Power to a Device
- Output Driver
- Relay
- DC Operated Buzzer
- Amplifier and Loudspeaker
- Seven Segment Display (Digital Signals)
- Logic Source Switches
- Logic Gates
- Threshold Detector (Comparator)
- Voltage Amplifier

### Signal Processing

- Automatic Light Switch System
- Fire Detector (Sprinkler) System
- Switch State Detector System
- Latching Switch System
- Voltage Divider
- Creating a Reference Voltage
- Sensor Voltage Divider
- Analogue Signals
- Digital Signals
- Combined Analogue/Digital Signals
- Lighting/Temperature Failure Warning System
- Thermostat with Time Switch Controller

## LIB 3: 27 Electronic Principles (Series 9 Practice)

### DC Circuits

- Voltage - Adjustment and Measurement
- Measuring Current
- Resistance
- Ohm's Law
- Power
- Other Ways to Calculate Power
- Resistor Measurements
- Troubleshooting Resistors
- The Series Circuit
- The Parallel Circuit
- Series-Parallel Combinations
- Kirchhoff's Voltage Law
- Kirchhoff's Current Law
- Troubleshooting Resistor Networks
- The Rheostat
- The Potentiometer
- Charging and Discharging a Capacitor
- Capacitor Charge Time
- Capacitor on a DC Supply
- Time Constant
- CR Integrator
- Troubleshooting a CR Integrator Circuit
- Kirchhoff's Voltage Law
- Kirchhoff's Current Law
- Investigation of a Wheatstone Bridge

### AC Circuits

- Voltage and Current
- Alternating Current - AC
- Alternating Voltage Values
- Capacitor on an AC Supply
- Troubleshooting an AC Supply Capacitor Circuit
- Capacitors with AC Applied
- Capacitors in Series
- Capacitors in Parallel
- Troubleshooting a Parallel Capacitor Network
- The Reservoir Capacitor
- Inductors with AC Applied
- Plotting Frequency Responses of RC and RL Circuits
- The Parallel Tuned Circuit

## Magnetism and Electromagnetism

- Attraction and Repulsion
- Other Magnetic Materials
- The Magnetic Field
- Electromagnet Field Plot
- The Magnetizing Effect on Different Core Materials
- Electromagnetic Induction
- The Solenoid
- Investigation of a Basic Transformer
- The Tapped Transformer
- Troubleshooting the Transformer
- The DC Motor
- The DC Generator
- Troubleshooting the DC Motor
- The Relay
- Investigating Change-Over and Latching Circuits
- Troubleshooting the Relay-1
- Troubleshooting the Relay-2

## LIB 3: 28 Linear Electronics (Series 9 Practice)

### Operational Amplifier Circuits

- Zero-Crossing Detector
- Comparator
- Feedback Amplifier
- Variation of Gain
- The Inverting AC Amplifier
- Troubleshooting an Inverting Amplifier
- Non-Inverting Amplifier
- The Non-Inverting AC Amplifier
- Unity Gain Amplifier - Voltage Follower
- Unity Gain Amplifier
- Summing Amplifier
- Troubleshooting Summing Amplifiers
- Regenerative Comparator Under DC Conditions
- Regenerative Comparator Under AC Conditions
- AC Comparator
- Investigation of an Integrator
- The AC Performance of an Inverting Amplifier
- The Frequency Performance of an Inverting Amplifier
- The AC Performance of a Non-Inverting Amplifier
- The Frequency Performance of a Non-Inverting Amplifier
- The High Frequency Performance of an Operational Amplifier
- Gain-Bandwidth Product in Practice
- Slew Rate Limitation of an Amplifier
- Troubleshooting Amplifiers

### Current Amplifier Circuits

- The Need for Power Amplification
- Operation of a Current Amplifier
- The Operation of a Push-pull Amplifier
- Improving the performance of Push-pull Amplifier (1)
- Improving the performance of Push-pull Amplifier (2)
- Measuring Power in Single-ended and Push-pull Amplifiers
- Troubleshooting Amplifiers



## LIB 3: 29 Semiconductors (Series 9 Practice)

### Diodes

- The PN Junction Diode
- Testing a Diode
- Troubleshooting Diode Circuits
- Half-Wave Rectifier
- Troubleshooting Rectifier Circuits
- The Zener Diode

### Transistors

- The Bipolar (Junction) Transistor - BJT
- Current Gain Characteristic
- Output Characteristic
- Transistor as a Switch
- NPN Transistor Switch
- Troubleshooting a Single Transistor Switch Circuit
- PNP Transistor Switch
- Regenerative NPN/PNP Switch
- Darlington Pair Switch Circuit
- Troubleshooting a Darlington Pair Switch Circuit
- Investigation of an N-channel JFET
- The Analog Switch

### Transistor Amplifiers

- Voltage Amplifier with DC Applied
- Voltage Amplifier with Alternating Input
- Simple Current Biasing
- Voltage Divider Biasing
- Emitter Decoupling Capacitor
- Troubleshooting a Common Emitter Amplifier
- Common Collector Amplifier - Emitter Follower
- Measurement of Quiescent Voltages
- Investigation of the Amplifier with an Applied Signal
- Loading a Voltage Divider
- Emitter Follower Circuits
- Troubleshooting a Darlington Pair Emitter Follower
- The Basic NPN/PNP Complementary Pair
- Elimination of Crossover Distortion
- Differential Amplifier Under DC Conditions
- Differential Amplifier Under AC Conditions
- JFET Common Source Amplifier Investigation

### SCRs

- Silicon Controlled Rectifier - SCR
- Capacitor Commutation
- DC Control of an SCR with AC Applied
- CR Phase Shift Control Circuit
- Uni-Junction Transistor - UJT
- UJT Phasing Pulse Generator
- Troubleshooting an AC Phase Control Circuit

## LIB 3: 30 Digital Electronics (Series 9 Practice)

### Number Systems

- Practical Investigation of Number Systems

### Sequential Logic

- The S-R Latch Constructed From NOR Gates (D3000 - 9.1)
- The S-R Latch Constructed From NOR Gates (D3000 - 9.2)
- The S-R Latch Constructed From NAND Gates (D3000 - 9.1)
- The S-R Latch Constructed From NAND Gates (D3000 - 9.2)
- Troubleshooting The S-R Latch (Function #2)
- The J-K Flip-Flop
- D-Type (Data) Flip-Flop
- T-Type (Toggling) Flip-Flop
- Shift Registers
- 3-Bit Up-Counter
- 3-Bit Down-Counter
- Binary Counter IC
- Modulo-N Counter

### Digital Systems

- 2-4 Line Decoder
- 4-2 Line Encoder
- Encoder-Decoder Circuit
- 1-4 Line Demultiplexer
- 4-1 Line Multiplexer
- Multiplexer-Demultiplexer Circuit
- 4-Bit Magnitude Comparator
- Half Adder
- Full Adder
- 4-Bit Binary Full Adder
- Three-State (Tri-State) Buffer
- 2-1 Multiplexer
- Bi-Directional Switch
- BCD Counter and 7-Segment Decoder
- Seven-Segment Display
- Analog Switch
- Astable IC Circuit
- Monostable IC Circuit
- Digital to Analog Converter
- Analog to Digital Converter

### Combinational Logic

- The NOT Gate (D3000 - 9.1)
- The NOT Gate (D3000 - 9.2)
- The AND Gate (D3000 - 9.1)
- The AND Gate (D3000 - 9.2)
- The OR Gate (D3000 - 9.1)
- The OR Gate (D3000 - 9.2)
- The NAND Gate (D3000 - 9.1)
- The NAND Gate (D3000 - 9.2)
- The NOR Gate (D3000 - 9.1)
- The NOR Gate (D3000 - 9.2)
- Boolean Expressions From Logic Circuits
- NOT Gate From a NAND Gate
- AND Gate From NAND Gates
- OR Gate From NAND Gates
- NOR Gate From NAND Gates
- The Exclusive-OR Gate (D3000 - 9.1)
- The Exclusive-OR Gate (D3000 - 9.2)
- The Exclusive-NOR Gate (D3000 - 9.1)
- The Exclusive-NOR Gate (D3000 - 9.2)
- Troubleshooting The Exclusive-NOR Gate
- Operation of the Schmitt NOT Gate
- Logic Gate Switches
- Combinational Logic Circuits
- Diode Logic
- Diode Transistor Logic (DTL)

## LIB 3: 31 Microprocessors (Series 9 Practice)

### The PIC Microcontroller

- Introduction to PICs
- Features of a PIC

### The PIC Development System

- Introduction to the PIC Basic Software
- Introduction to the PIC Shell Software
- Introduction to the Software and Hardware

### Developing PIC Programs

- Defining Device Type and Clock Speed
- Programming Fundamentals
- The PIC Ports
- Writing Programs to use the Ports
- Loops and Conditional Branching
- Using Loops and Conditional Branching
- Arithmetic and Logic Operations
- Creating Delays
- Using Arithmetic and Logic Operations
- Introduction to Interrupts
- Commands to set up an Interrupt on Portb
- Using an Interrupt on Portb

## LIB 3: 32 Engine Repair

### Engine Fundamentals

- Introduction to Engine Systems
- Four Stroke Cycle (Auto Rig)
- Position and Mounting of Engine Components (Rig)
- Front End Component Identification (Auto Rig)
- Common Rail Diesel Engine Operation (Auto Rig)
- Common Rail Diesel Engine Component Identification (Auto Rig)
- Sectioned (CI) Engine Component Identification (Rig)

### Cylinder Head and Valve Trains

- Components of the Top End
- Top End Component Identification (Auto Rig)
- Engine Cycles, Valve and Ignition Timing
- Camshafts and Valve Lifters
- Valve Trains

### Engine Block

- Components of the Bottom End
- Bottom End Component Identification (Auto Rig)
- Engine Blocks and Liners
- CI Engine Size (Rig)
- Pressure and Volume
- Engine Size (Auto Rig)
- Pistons
- Crankshaft and Piston Operation (Rig)

### Engine Servicing

- Basic Engine Service Procedures (Workshop)
- Inspect and Repair Threads (Workshop)
- Engine Removal and Replacement (Workshop)
- Cooling System Inspection, Test and Repair (Workshop)
- Manifold Vacuum Test (Workshop)
- Cylinder Compression Test (Workshop)
- Cylinder Power Balance Test (Workshop)
- Cylinder Leakage Test (Workshop)
- Adjustment of Valve Clearances on an OHC Engine (Workshop)
- Camshaft Timing Verification (Workshop)
- The Crankshaft Sensor (Workshop)

### Lubrication and Cooling Systems

- Lubrication Systems
- Engine Oil Pressure
- Engine Oil Pressure (Board)
- Engine Oil Pressure (Panel)
- Lubrication System Inspection (Workshop)
- Cooling Systems
- Vehicle Cooling System Inspection (Workshop)
- Adjusting Drive Belt Tension (Workshop)

## LIB 3: 33 Automatic Transmission and Transaxle

### Transmission System Fundamentals

- Introduction to Automatic Transmissions
- Automatic Transmission Systems
- Automatic Transmission Operation (Auto Rig)

### Final Drives

- Drivetrain and Driveline
- Locating Driveline Components (Workshop)
- Front Wheel Final Drive Systems
- Rear Wheel Final Drive Systems

### Automatic Transmission Servicing

- Automatic Transmission Diagnostic Checks (Workshop)

### Automatic Transmission Components

- Torque Converter
- Torque Converter (Auto Rig)
- Planetary Gears, Clutches, and Bands
- Gears and Planetary Gear Sets
- Automatic Transmission Gears (Auto Rig)
- Electrical and Electronic Controls

## LIB 3: 34 Manual Drive Train and Axles

### Manual Transmission System Fundamentals

- Manual Transmission Introduction
- Manual Transmissions
- Clutch and Manual Transmission Systems
- Gears and Gear Ratios (Auto Rig)

### Manual Transmission and Driveline Servicing

- Clutch Removal, Inspection, and Refitting
- Clutch System - Symptoms and Faults
- Drive Shaft Servicing Procedures (Workshop)
- Inspecting FWD Shafts and Joints (Workshop)
- Inspecting the Complete Transmission System of a Vehicle (Workshop)

### Manual Transmission Components and Operation

- Manual Transmission Construction (Auto Rig)
- Transmission Operation (Auto Rig)
- Clutch Construction and Operation
- Clutch Design
- Gears and Speed
- Gears and Speed (Panel)
- Gears and Speed (Board)
- Manual Transaxles
- Differential (Rig)
- Front Wheel Drive Shafts
- Selector Lever and Selector Forks (Rig)
- Rear Wheel Drive Shafts

## LIB 3: 35 Suspension

### Suspension System Fundamentals

- Suspension Systems 1
- Suspension Systems 2
- Geometry Fundamentals

### Suspension Components and Operation

- Control Arms
- Springs and Shock Absorbers
- Coil Springs
- Torsion Bars
- Leaf and Rubber Springs
- MacPherson Struts

### Inspection and Repair

- Geometry Adjustments
- Remove, Inspect, and Install Transverse Links and Strut Rods (Workshop)
- Remove, Inspect, and Install Upper and Lower Control Arms (Workshop)

- Remove, Inspect and Install Ball Joints on Suspension Systems (Workshop)
- Removal, Inspection and Installation of Coils Springs and Insulators (Workshop)
- How to Check Shock Absorbers for Leaks (Auto Rig)
- Inspect, Remove, and Replace Shock Absorbers (Workshop)
- MacPherson Strut Coil Spring Removal and Inspection (Auto Rig)
- MacPherson Strut Removal, Inspection, and Re-installation Procedures (Workshop)
- Remove, Inspect, Install and Adjust Torsion Bars (Workshop)
- Remove, Inspect and Install Stabilizer Bushings, Brackets and Links (Workshop)
- Remove, Inspect, Install, and Adjust Strut Rods and Bushings (Workshop)
- Leaf Spring Removal, Inspection, and Re-installation Procedures (Workshop)

## LIB 3: 36 Steering

### Steering System Components and Operation

- Steering Systems
- Conventional Steering System Components
- Steering Rack
- The Steering Column
- Tie Rods
- Power Steering Systems
- Electronic Steering Systems
- Introduction to the Steering and Suspension Trainer (Auto Rig)
- Using the Power Steering on the Steering and Suspension Trainer (Auto Rig)

### Inspection and Repair

- Adjusting Wheel Height (Auto Rig)
- Steering Column Inspection (Auto Rig)
- Steering Column Inspection (Workshop)
- Steering Column Fault Diagnosis (Workshop)
- Steering Wheel Adjustment (Auto Rig)
- Check Power Steering System (Workshop)
- Check and Top-Up Power Steering Fluid (Auto Rig)
- Flushing and Bleeding the Power Steering System (Auto Rig)
- Remove and Inspect Conventional Steering Components (Workshop)
- Remove, Inspect, and Replace Conventional Steering Components (Workshop)
- Adjustment of Steering Box Pre-Load (Workshop)
- Tie Rod Removal and Adjustment (Auto Rig)
- Steering Knuckle Removal and Inspection (Auto Rig)
- Rack and Pinion Gear Service (Workshop)
- Removing Rack and Pinion Steering Gear (Auto Rig)
- Diagnose Power Steering Problems (Workshop)
- Check Front Cradle (Subframe) Alignment (Workshop)
- Working on Electronically Controlled Suspension and Steering Systems (Workshop)

### Wheels and Tires

- Wheel and Tire Fundamentals
- Road Wheels
- Tires
- Tire Wear and Rotation
- Tire Inspection and Repair
- Wheel and Tire Diagnosis
- Tire Changing and Wheel Balancing
- Wheel Balancing Principles
- Wheel and Tire Runout
- Wheel Alignment
- Wheel Bearings

### Wheel and Tire Servicing

- Tire Inspection and Inflation (Workshop)
- Tire Inspection (Workshop)
- Road Wheel Removal and Installation (Workshop)
- Tire Rotation (Workshop)
- Perform Pre-alignment Inspection (Workshop)
- Ride Height Measurement (Workshop)
- Caster, Camber, Toe, and Setback Checks and Adjustment (Workshop)
- Check Steering Axis Inclination and Toe-out on Turns (Workshop)
- Wheel Alignment Checks (Workshop)
- Measure Wheel, Tire, Axle and Hub Runout (Workshop)
- Balance Wheel and Tire Assembly (Workshop)
- Tire Repair Workshop Procedure (Workshop)
- Wheel Bearing Maintenance (Workshop)
- Wheel Bearing Replacement Procedure (Workshop)
- Sealed Wheel Bearing Replacement Procedure (Workshop)
- Wheel Stud Replacement Procedure (Workshop)

## LIB 3: 37 Brake Systems

### Brake System Fundamentals

- Brake Systems 1
- Brake Systems 2
- Friction

### Hydraulic Control

- Fluid Power Concepts
- Basic Fluid Power Engineering

### Warning Systems

- Brake Warning Systems
- Brake Fluid Warning System
- Brake Fluid Warning System (Board)
- Brake Fluid Warning System (Panel)

### Anti-Lock Braking Systems

- Anti-Lock Brake Systems
- Anti-Lock Brake Trainer (Panel)
- ABS Braking Cycle (Panel)
- Wheel Speed Sensors
- Inductive Sensor Investigation (Panel)
- Hall Effect Sensor Investigation (Panel)
- Troubleshooting ABS Input Devices 1 (Panel)
- Troubleshooting ABS Input Devices 2 (Panel)

- Troubleshooting ABS Input Devices 3 (Panel)
- Sensors and Switches
- Brake Pedal Travel Sensor (Panel)
- Troubleshooting ABS Input Devices 4 (Panel)
- Brake Fluid Level Switch (Panel)
- Troubleshooting ABS Input Devices 5 (Panel)
- Hydraulic Pump Motor Speed Sensor (Panel)
- Troubleshooting ABS Input Devices 6 (Panel)
- Brake Pedal Switch (Panel)
- ABS ECU Circuits and Signals
- ABS Relay (Panel)
- ABS Warning Lamp and Diode (Panel)
- Troubleshooting ABS Output Devices 1 (Panel)
- Troubleshooting ABS Output Devices 2 (Panel)
- Troubleshooting ABS Output Devices 3 (Panel)
- Troubleshooting ABS Output Devices 4 (Panel)
- Troubleshooting ABS Output Devices 5 (Panel)
- Troubleshooting ABS Output Devices 6 (Panel)
- Hydraulic Control Unit (Panel)
- Hydraulic Pump and Motor (Panel)

### Advanced Brake Systems

- Electronic Brake Systems Introduction
- Stability Control Systems
- Stability Control Electronics and Hydraulics
- Diagnosing Faults in ESP Systems

## LIB 3: 38 Brake Components

### Brake System Fundamentals

- Introduction to the Brake Systems Trainer (Auto Rig)

### Drum Brakes

- Brake Drums
- Brake Shoes
- Parking Brakes
- Wheel Cylinders

### Power Assistance

- Vacuum Brake Boosters
- Hydraulic Brake Boosters

### Disc Brakes

- Brake Rotors
- Brake Calipers
- Brake Pads
- Integral Caliper Parking Brake

### Hydraulic Control

- Hydraulics
- Basic Control Valves
- Pressure Control Valves
- The Master Cylinder
- Brake Lines and Hoses
- Brake Fluid

## LIB 3: 39 Brake Servicing

### Brake System Fundamentals

- Braking Forces
- Braking Calculations

### Drum Brake System Servicing

- Drum Brake Removal and Inspection (Auto Rig)
- Drum Brake Removal, Disassembly and Inspection (Auto Rig)
- Brake Shoe Replacement (Auto Rig)
- Wheel Cylinder Removal and Inspection (Workshop)
- Adjusting the Parking Brake (Auto Rig)
- Machining a Drum (Workshop)

### Disc Brake System Servicing

- Brake Caliper Inspection (Auto Rig)
- Brake Pad Removal and Brake Assembly Inspection (Auto Rig)
- Brake Pad Replacement (Auto Rig)
- Brake Rotor Replacement (Auto Rig)
- Measuring Brake Rotors (Auto Rig)
- Brake Pad Wear Indicator Inspection
- Integral Caliper Parking Brake Service (Workshop)
- Machining a Rotor (Workshop)

### Brake Line Servicing

- Brake Line Inspection (Workshop)
- Brake Line Fabrication (Workshop)
- Fabricating Brake Lines (Workshop)

### Brake System Servicing

- Brake Pedal Height
- Checking Pedal Heights and Adjusting Push Rod Length (Workshop)
- Bleed Brake System (Manual Bleed) (Workshop)
- Parking Brake Cable Replacement (Auto Rig)
- Master Cylinder Inspection (Workshop)
- Master Cylinder Removal, Bench Bleed, and Reinstall (Workshop)
- Flush Brake System (Workshop)
- Bleeding a Pressurized Anti-lock Braking System (Workshop)
- Test Vacuum Brake Booster Procedure (Workshop)
- Vacuum Leak Testing Procedure (Workshop)
- Vacuum Supply Testing Procedure (Workshop)
- Vacuum Supply Testing Procedure (Workshop)
- ABS Servicing Procedure (Workshop)
- De-pressurize High-pressure Components of the Anti-lock Brake System (Workshop)
- Replacing ABS Component Procedure (Workshop)
- Testing the Anti-lock Braking System (Workshop)
- Troubleshooting a Braking System (Workshop)
- Testing the Brake Lamp Switch Circuit (Workshop)
- Test Brake Light Switch (Workshop)



## LIB 3: 40 Automotive Electrical Fundamentals

### Electrical Fundamentals

- Simple Circuits
- Simple Battery and Lamp Circuit (Board)
- Controlling and Protecting Simple Circuits
- Simple Battery, Lamp, and Switch Circuit (Board)
- Simple Battery, Lamp, Switch and Fuse Circuit (Board)
- Common Ground Circuits and Wiring Diagrams
- Common Ground Circuits (Board)
- Wiring Diagrams (Board)
- DC and AC Current
- Current Flow in a Simple Circuit (Board)
- Power
- Continuity and Circuit Faults
- Continuity (Board)
- Circuit Faults (Board)
- Pushbutton Switches and Switch Circuits
- Pushbutton Switches (Board)
- Switches in Series and Parallel (Board)
- Changeover Switches
- Two-Position Changeover Switches (Board)
- Two-Position, Two-Pole Changeover Switches (Board)
- Resistance and Ohm's Law
- Ohm's Law (Board)
- Resistance (Board)
- Electricity
- Electrical Circuits
- Electromagnetic Principles
- Electrical Safety and Circuit Checks
- Introduction to Wiring Diagrams
- Control Principles
- Control Examples
- Information Flow
- Physical Environment to Electrical Transformation

### Electrical Components and Operations

- Capacitor Types and Applications
- Diode Types and Applications
- Transistors
- Relays
- The Relay (Board)
- Signal Processing
- Sensors
- Types of Control Signals

### Electrical Supply

- Batteries
- Battery and Fuse Investigation (Board)
- Battery and Fuse Investigation (Panel)
- Battery and Fuse Circuit Fault Investigation 1 (Board)
- Battery and Fuse Circuit Fault Investigation 1 (Panel)
- Battery and Fuse Circuit Fault Investigation 2 (Board)
- Battery and Fuse Circuit Fault Investigation 2 (Panel)

### Electrical Measurement

- Electrical Test Equipment
- Using a Multimeter
- Voltage, Resistance, and Continuity (board)
- Measuring Current
- Reading Wiring Diagrams
- Voltage Drop
- Calculating and Adjusting Permitted Voltage Drop
- Electrical Circuit Testing (workshop)
- Symbols, Device Markings and Terminal Block Designations

## LIB 3: 41 Automotive Starting and Charging

### Charging System Fundamentals

- Charging Principles
- Magnetism and Electromagnetism
- Charging Systems
- Alternator Construction
- Work of the Regulator

### Charging System Inspection and Test

- Alternator Output Tests
- Alternator Output Tests (Workshop)
- Alternator Output Waveforms (Board)
- Alternator Output Waveforms (Panel)
- Charging System Fault Diagnosis
- Alternator Fault Investigation 1 (Board)
- Alternator Fault Investigation 1 (Panel)
- Alternator Fault Investigation 2 (Board)
- Alternator Fault Investigation 2 (Panel)
- Alternator Service Procedure (Workshop)
- Replacing an Alternator and Drive Belt (Workshop)

### Starting System Fundamentals

- Starting Systems
- Starting and Charging
- Starting and Charging (Panel)
- Starting and Charging (Board)

### Starting System Inspection and Test

- Starter Motor and Solenoid Measurements (Board)
- Starter Motor and Solenoid Measurements (Panel)
- Starter Control Circuit Service (Workshop)
- Performing Voltage Drop and Current Draw Tests (Workshop)
- Starter Relay & Solenoid Testing, Starter Motor Replacement (Workshop)
- Starting System Fault Diagnosis
- Starting System Problems (Board)
- Starting System Problems (Panel)
- Wire Repair (Workshop)

## LIB 3: 42 Automotive Lighting

### Lighting Circuit Fundamentals

- Types of Light Sources
- Lighting Systems
- Lighting Systems (Board)
- Lighting Systems (Panel)
- Series Lamp Circuits
- Identical Lamps in Series (Board)
- Non-Identical Lamps in Series (Board)
- Parallel Lamp Circuits
- Identical Lamps in Parallel (Board)
- Identical Lamps in Parallel (Board) [700-10]
- Power in a Simple Lamp Circuit (Board)
- Three-Position Changeover Switches (Board)
- Non-Identical Lamps in Parallel (Board)

### Headlight Circuits

- Headlamps 1
- Headlamps 2
- Headlights (Board)
- Headlights (Panel)
- Low and High Beam Circuits (Board)
- Headlamp Flash Circuit
- High Beam Flash Circuit (Board)
- Three-Pin Relay Headlamp Circuit (Board)
- Four-Pin Relay Headlamp Circuit (Board)
- Relay and Spot Lamp Circuit (Board)
- Automatic Lighting
- Automatic Lighting (Board)

## Park and Tail Light Circuits

- Park and Tail Lighting
- Park and Tail Lamp Circuits (Board)
- Park and Tail Lights (Board)
- Park and Tail Lights (Panel)
- Park, Tail, and Headlamp Circuits 1
- Park, Tail, and Headlamp Circuits 1 (Board)
- Park, Tail, and Headlamp Circuits 2 (Board)

## Stop and Backup Light Circuits

- Stop and Backup Lamps
- Stop and Backup Lamp Circuits (Board)
- Stop Lamp Circuit Investigation (Board)
- Stop Lamp Circuit Investigation (Panel)
- Backup Lamp Circuit Investigation (Board)
- Backup Lamp Circuit Investigation (Panel)

## Turn Signal Circuits

- Turn Signal Systems
- Turn Signal Circuit (Board)
- Turn Signal and Hazard Warning Circuit Investigation (Board)
- Turn Signal and Hazard Warning Circuit Investigation (Panel)

## Hazard Warning Lighting Circuit

- Hazard Warning Lamps
- Hazard Warning Circuit (Board)

## Internal Lighting Circuits

- Internal Lighting
- Internal Lamp Circuit Investigation (Panel)
- Internal Lamp Circuits (Board)

## Lighting Circuit Fault Diagnosis

- Introduction to Fault-Finding
- Lighting Fault Diagnosis
- Fault-Finding Example (Board)
- Lighting Circuit Fault Investigation 1 (Board)
- Lighting Circuit Fault Investigation 1 (Panel)
- Lighting Circuit Fault Investigation 2 (Board)
- Lighting Circuit Fault Investigation 2 (Panel)
- Lighting Circuit Fault Investigation 3 (Board)
- Lighting Circuit Fault Investigation 3 (Panel)
- Lighting Systems Fault Diagnosis 1
- Lighting Systems Fault Diagnosis 1 (Board)
- Lighting Systems Fault Diagnosis 1 (Panel)
- Lighting Systems Fault Diagnosis 2
- Lighting Systems Fault Diagnosis 3
- Headlamp Lighting Fault 1 (Board)
- Headlamp Lighting Fault 2 (Board)
- Headlamp Lighting Fault 3 (Board)
- High Beam Flash Circuit Fault (Board)
- Low and High Beam Circuit Fault (Board)
- Three Pin Relay Headlamp Circuit Fault (Board)
- Four Pin Relay Headlamp Circuit Problem Solving (Board)
- Park and Tail Lamp Circuit Fault (Board)
- Park and Tail Lighting Fault (Board)
- Park, Tail, and Headlamp Circuit Fault 1 (Board)
- Park, Tail, and Headlamp Circuit Fault 2 (Board)
- Park, Tail, and Headlamp Circuit Problem Solving (Board)
- Backup Lamp Circuit Fault (Board)
- Turn Signal Circuit Fault (Board)
- Turn Signal and Hazard Warning Circuit Fault Investigation (Board)
- Turn Signal and Hazard Warning Circuit Fault Investigation (Panel)
- Hazard Warning Circuit Fault (Board)
- Interior Lamp Circuit Fault (Board)

## LIB 3: 43 Automotive Transducers

### Transducer Circuits and Components

- Engine Coolant Temperature Sensor
- Coolant Temperature Sensor (Board)
- Coolant Temperature Sensor (Panel)
- Testing the Engine Coolant Temperature Sensor (Workshop)
- Mass Airflow Sensor
- Air Flow Sensor (Board)
- Air Flow Sensor (Panel)
- Intake Air Temperature Sensor
- Throttle Position Sensor
- Oxygen Sensor
- Oxygen Sensor (Board)
- Oxygen Sensor (Panel)
- Crankshaft Position Sensor
- Vehicle Speed Sensor (Board)
- Vehicle Speed Sensor (Panel)
- Performing a Gauge Circuit Test (Workshop)

### Transducer Fault Diagnosis

- Fault Investigation 1 (Board)
- Transducer Fault 1 (Panel)
- Fault Investigation 2 (Board)
- Fault Investigation 2 (Panel)
- Transducer Fault 2 (Board)
- Transducer Fault 2 (Panel)
- Fault Investigation 4 (Board)
- Fault Investigation 4 (Panel)

## LIB 3: 44 Ignition Systems

### Ignition System Fundamentals

- Introduction to Ignition Systems
- Breaker Point Ignition Systems (Board)
- Breaker Point Ignition Systems (Panel)
- Transistor Assisted Ignition Systems (Panel)
- Transistor Assisted Ignition Systems (Board)
- Ignition Coil Investigation (Panel)
- Ignition Coil Investigation (Board)
- Spark Plugs

### Distributorless Electronic Ignition Systems

- Distributorless Ignition Systems
- Distributorless Ignition Systems (Panel)
- Distributorless Ignition Systems (Board)
- DIS Trainer Features (Auto Rig)
- DIS Trainer Operation (Auto Rig)
- DIS Trainer Waveforms (Auto Rig)
- DIS Trainer Temperature Sensor (Auto Rig)
- DIS Trainer Crankshaft Sensor (Auto Rig)

### Distributor Electronic Ignition Systems

- Inductive Reluctance Electronic Ignition Systems (Panel)
- Inductive Reluctance Electronic Ignition Systems (Board)
- Hall Effect Electronic Ignition Systems (Panel)
- Hall Effect Electronic Ignition Systems (Board)

## Ignition System Servicing

- Inspection and Testing of the Ignition Primary Circuit (Workshop)
- Ignition Secondary Circuit Inspection (Workshop)
- Inspection and Testing of an Ignition Coil (Workshop)
- Distributor Testing (Workshop)
- The Magnetic Pulse Generating Pickup (Workshop)
- The Ignition Control Module (ICM) (Workshop)
- The Hall Effect Ignition System (Workshop)
- The Optical Ignition System (Workshop)
- Spark Plug Removal, Reading, Gapping, and Refitting (Workshop)
- Ignition System Wavepattern Investigation (Workshop)
- Ignition Timing Check and Adjustment (Workshop)
- Variable Dwell Investigation (Workshop)
- Testing Optical Ignition Systems (Workshop)

## Ignition System Diagnosis

- Lack of Power Problem (Auto Rig)
- Extremely Rough Idle Problem 1 (Auto Rig)
- Extremely Rough Idle Problem 2 (Auto Rig)
- No Start Problem 1 (Auto Rig)
- No Start Problem 2 (Auto Rig)
- No Start Problem 3 (Auto Rig)
- Troubleshooting Transistor Assisted Ignition Systems (Panel)
- Troubleshooting Transistor Assisted Ignition Systems (Board)
- Troubleshooting Breakerless Ignition Systems (Panel)
- Troubleshooting Breakerless Ignition Systems (Board)
- Troubleshooting Distributorless Ignition Systems (Panel)
- Troubleshooting Distributorless Ignition Systems (Board)

# LIB 3: 45 Engine Management and Control

## Engine Management System Fundamentals

- Engine Management System
- Engine Management System Fundamentals (Rig)
- Electronic Control Unit
- Decision Making Processes (Board)
- Decision Making Processes (Panel)
- Fuel Injection System Decisions (Board)
- Fuel Injection System Decisions (Panel)
- Ignition System Decisions (Board)
- Ignition System Decisions (Panel)
- On Board Diagnostics Two (OBDII) Systems
- Starting Management, Control, and Regulation
- Air Management in a Diesel Engine

## Sensors

- Sensors and Actuators
- Sensor Components (Rig)
- Engine Sensor Fault Diagnosis 1
- Engine Sensor Fault Diagnosis 2
- Engine Coolant Temperature
- Engine Coolant Temperature (Panel)
- Engine Coolant Temperature (Board)

## Actuators

- Actuator Components (Rig)

## Engine Inspection

- Thermostatic Air Cleaner Inspection and Test (Workshop)
- Positive Crankcase Ventilation System - Inspection and Test (Workshop)
- Pulse Air Injection System - Inspection and Test (Workshop)
- Evaporative Emissions Control Systems - Inspection and Test (Workshop)
- Retrieval and Clearing of OBD I Trouble Codes (Workshop)
- Retrieval and Clearing of OBD II Trouble Codes (Workshop)
- The Engine Coolant Temperature (ECT) Sensor (Workshop)
- The Throttle Position Sensor (TPS) (Workshop)
- The Oxygen (O<sub>2</sub>) Sensor (Workshop)
- The Intake Air Temperature (IAT) Sensor (Workshop)
- The Mass Airflow (MAF) Sensor (Workshop)
- The Idle Air Control (IAC) Valve (Workshop)
- The Digital EGR Valve (Workshop)
- Coolant Servicing (Workshop)
- Thermostat Servicing (Workshop)

## Engine Management Fault Investigation

- Engine Management System Fault Diagnosis
- Diesel Engine Fault Diagnosis
- Fault Investigation 5 (Board)
- Fault Investigation 5 (Panel)
- Fault Investigation 6 (Board)
- Fault Investigation 6 (Panel)
- Engine Fault Diagnosis 1 (Rig)
- Engine Fault Diagnosis 2 (Rig)
- Engine Fault Diagnosis 3 (Rig)
- Engine Fault Diagnosis 4 (Rig)
- Engine Fault Diagnosis 5 (Rig)
- Engine Fault Diagnosis 6 (Rig)
- Engine Fault Diagnosis 7 (Rig)
- Engine Fault Diagnosis 8 (Rig)
- Engine Fault Diagnosis 9 (Rig)
- Engine Fault Diagnosis 10 (Rig)

## LIB 3: 46 Fuel and Emissions

### Fuel Components and Operation

- Fuel Injection Fundamentals
- Electronic Multipoint Fuel Injection Systems
- Fuel Injectors (Board)
- Fuel Injector Pulse Width (Board)
- Fuel Injector Pulse Frequency (Board)
- Fuel Injector Pulse Timing (Board)
- Fuel Injectors (Panel)
- Fuel Injector Pulse Width (Panel)
- Fuel Injector Pulse Frequency (Panel)
- Fuel Injector Pulse Timing (Panel)
- Electric Fuel Pump (Board)
- Electric Fuel Pump (Panel)
- Introduction to the EFI Demonstrator (Rig)
- Pressurized Fuel Systems (Rig)
- Fuel Injector Pulse Width (Rig)
- Fuel Injector Pulse Frequency (Rig)
- Fuel Injector Pulse Timing (Rig)
- EFI Fuel Injector Pulse Frequency (Rig)
- EFI Fuel Injector Pulse Timing (Rig)
- EFI Pressurized Fuel Systems (Rig)
- Fuel Injection Components (Rig)
- EFI Fuel Injector Pulse Width (Rig)
- Actuator Circuits and Components (Rig)

### Air Induction Components and Operation

- Air Management
- Sensor Circuits and Components (Rig)
- Idle Air Control Valve (Board)
- Idle Air Control Valve (Panel)

### Emission Control Systems

- Catalytic Converter
- Exhaust Gas Recirculation Systems
- Air Injection Systems
- Exhaust Emission Control Components (Rig)
- The Electronic Control Unit (ECU) (Rig)

## Fuel and Emissions System Servicing

- Fuel System Inspection (Workshop)
- Intake Air System Inspection (Workshop)
- Cold Enrichment System Inspection and Test (Workshop)
- Mixture Control Solenoid Duty Cycle Investigation (Workshop)
- Idle Speed and Fuel Mixture Adjustment (Workshop)
- Inspecting and Draining a Fuel System (Workshop)
- Fuel Filter Inspection (Workshop)
- Fuel Pump Inspection & Pressure Testing (Workshop)
- Fuel Pressure on an Electronic Fuel Injection System (Workshop)
- Throttle Body Injection Servicing (Workshop)
- Checking the Operation of Solenoid Operated Fuel Injectors (Workshop)
- Throttle Body Servicing (Workshop)
- Fuel Injector - Inspection, Testing, and Cleaning (Workshop)
- Turbocharger System - Inspection and Testing (Workshop)
- Fuel Trim and Exhaust Emissions Monitoring (Workshop)
- Fuel Injection System Fault Diagnosis
- Exhaust Gas Analyzer (Workshop)
- Exhaust System Inspection and Testing (Workshop)
- Investigation of Exhaust Emission Levels (Workshop)
- Catalytic Converter Inspection and Efficiency Testing (Workshop)
- Early Exhaust Recirculation System - Inspection and Test (Workshop)
- EFI Demonstrator Fault Diagnosis 1 (Rig)
- EFI Demonstrator Fault Diagnosis 2 (Rig)
- EFI Demonstrator Fault Diagnosis 4 (Rig)
- EFI Demonstrator Fault Diagnosis 5 (Rig)
- EFI Demonstrator Fault Diagnosis 6 (Rig)
- EFI Demonstrator Fault Diagnosis 7 (Rig)
- EFI Demonstrator Fault Diagnosis 8 (Rig)
- EFI Demonstrator Fault Diagnosis 9 (Rig)
- EFI Demonstrator Fault Diagnosis 10 (Rig)

## Diesel Engine Management

- Common Rail Diesel Engine
- Fuel in a Diesel Engine
- Fuel Injection Management in a Diesel Engine
- Exhaust Management System

## LIB 3: 47 Electric and Hybrid Vehicle Technology

### Electric Vehicles

- Definition of Electric Vehicles
- Fuel Cells
- The Principle of the Fuel Cell
- Electric Motors
- Three-Phase AC
- Features of Electric Vehicles
- Range Extenders

### High Voltage Electric Vehicles

- High Voltage Vehicles
- Reasons for the Development of High Voltage Vehicles
- NiMH Batteries
- Principles of NiMH Batteries
- Lithium-ion Batteries
- Principles of Lithium-ion Batteries
- Safety with Batteries
- High Voltage Wiring and Connectors
- Voltage Converters
- The Inverter Principle
- The DC to DC Converter
- The Motor-Generator
- The Rotating Magnetic Field
- Safety in High Voltage Vehicles
- Legal Regulations
- Special Equipment for High Voltage Testing and Repair
- Working on High Voltage Vehicles
- Qualifications for Working on High Voltage Vehicles

### Hybrid Vehicles

- Classification of Hybrid Vehicles by Power Source
- Features of Hybrid Vehicles
- Classification of Hybrid Vehicles by Engine Arrangement
- Diagnose Insulation Measurement Faults
- Diagnose Equipotential Faults

### Hybrid and Electric Vehicle Systems

- Introduction to Hybrid and Electric Vehicles
- Fuel and Emissions
- Series Hybrid Systems
- Parallel Hybrid Systems
- Series Parallel Systems and Components
- Practical Series Parallel Hybrid Systems
- Introduction to the Hybrid Vehicle Trainer
- Hybrid Vehicle Trainer Controls
- Plug-in Electric Vehicles
- Plug-in Hybrid Vehicles
- The High Voltage System
- The Low Voltage System
- Troubleshooting Introduction
- AC Motors and Generators
- Hybrid Electric Motors
- Hybrid Engines
- Electronic Circuits and Modules
- Cables, Connectors and Protection Devices
- Introduction to Electrical Storage Devices
- Lead Acid Batteries
- Nickel Metal Hydride Batteries
- Lithium-ion Batteries
- Battery Packs
- Brake Systems
- Hybrid Safety Issues and Concerns
- Troubleshooting the High Voltage System
- Disabling Hybrid Vehicle Systems
- Disabling the High Voltage System



## LIB 3: 48 Networked Systems

### Networked Systems Structure

- The CAN Data Bus
- The LIN Data Bus
- The MOST Data Bus

### Networked Systems Data

- CAN Bus Data Processing
- Transmitting CAN Data
- CAN Signal Response
- CAN Bus Fault Diagnosis
- CAN Bus Fault Diagnosis - 2
- CAN Bus Fault Diagnosis - 3
- CAN Bus Fault Diagnosis - 4
- CAN Bus Fault Diagnosis - 5
- CAN Bus Fault Diagnosis - 6

## LIB 3: 49 CAN Bus Lighting Systems

### Lighting Systems Operation

- Using Auto CAN Lighting for the First Time
- CAN Bus Lighting Systems
- CAN Bus Lighting Systems (Board)
- CAN Bus Lighting Control
- CAN Bus Lighting Control (Board)
- CAN Bus Park, Tail, and Headlight Systems
- CAN Bus Park, Tail, and Headlight Systems (Board)
- CAN Bus Fog Light Systems
- CAN Bus Fog Light Systems (Board)
- CAN Bus Turn Signal and Hazard Warning Systems
- CAN Bus Turn Signal and Hazard Warning Systems (Board)
- CAN Bus Stop and Backup Light Systems
- CAN Bus Stop and Backup Light Systems (Board)
- The Lighting Systems' CAN Bus
- The Lighting Systems' CAN Bus (Board)

### Lighting Systems Measurement

- CAN Bus Lighting Systems Measurement
- CAN Bus Park and Tail Light System Measurement (Board)
- CAN Bus Headlight System Measurement (Board)
- CAN Bus Fog Light System Measurement (Board)
- CAN Bus Turn Signal and Hazard Warning System Measurement (Board)
- CAN Bus Stop and Backup Light System Measurement (Board)
- CAN Data Bus Measurement
- CAN Data Bus Measurement (Board)

### Lighting Systems Diagnosis

- CAN Bus Lighting Faults
- CAN Bus Lighting Fault 1 (Board)
- CAN Bus Lighting Fault 2 (Board)
- CAN Bus Lighting Fault 3 (Board)
- CAN Bus Lighting Fault 4 (Board)
- CAN Bus Lighting Fault 5 (Board)
- CAN Bus Lighting Fault 6 (Board)
- CAN Bus Lighting Fault 7 (Board)
- CAN Bus Lighting Fault 8 (Board)
- CAN Bus Lighting Control Fault 1 (Board)
- CAN Bus Lighting Control Fault 2 (Board)

## LIB 3: 50 CAN Bus Auxiliary Systems

### Auxiliary Systems Operation

- Auxiliary CAN Bus Systems
- Effect of a Disconnected CAN Bus Control Module
- The Auxiliary Systems' CAN Bus
- The Auxiliary Systems' CAN Bus (Board)
- CAN Bus Window, Mirror, and Seat Systems
- CAN Bus Window, Mirror, and Seat Systems (Board)
- CAN Bus Power Door Locking System
- CAN Bus Power Door Locking System (Board)
- Auxiliary CAN Bus Door Mirror Control Systems
- Auxiliary CAN Bus Safety Systems
- Auxiliary CAN Bus Security Systems
- Auxiliary CAN Bus Window Control Systems

### Auxiliary Systems Measurement

- CAN Data Bus Measurement
- CAN Data Bus Measurement (Board)
- Multimeter Tests on an Auxiliary CAN Bus System
- CAN Bus Window, Mirror, and Seat Systems Measurement
- CAN Bus Mirror System Measurement (Board)
- CAN Bus Window System Measurement (Board)
- CAN Bus Seat System Measurement (Board)
- CAN Bus Power Door Locking System Measurement
- CAN Bus Power Door Locking System Measurement (Board)
- Oscilloscope Tests on an Auxiliary CAN Bus System
- Analyzer Tests on an Auxiliary CAN Bus System

### Auxiliary Systems Diagnosis

- Testing Auxiliary CAN Bus Systems
- Auxiliary CAN Bus Fault Tolerance
- Faults in Auxiliary CAN Bus Systems
- Open Circuit Auxiliary CAN Bus Faults
- Short Circuit Auxiliary CAN Bus Faults
- CAN Bus Auxiliary Faults
- CAN Bus Auxiliary Fault 1 (Board)
- CAN Bus Auxiliary Fault 2 (Board)
- CAN Bus Auxiliary Fault 3 (Board)
- CAN Bus Auxiliary Fault 4 (Board)
- CAN Bus Auxiliary Fault 5 (Board)
- CAN Bus Auxiliary Fault 6 (Board)
- CAN Bus Auxiliary Fault 7 (Board)

## LIB 3: 51 CAN Bus Starting and Charging Systems

### Starting and Charging Systems Operation

- CAN Bus Starting and Charging Systems
- The Starting and Charging Systems' CAN Bus
- The Starting and Charging Systems' CAN Bus (Board)
- CAN Bus Conventional Starting and Charging System (Board)
- CAN Bus Advanced Starting and Charging System (Board)
- Automatic Stop-Start System (Board)

### Starting and Charging Systems Measurement

- CAN Data Bus Measurement
- CAN Data Bus Measurement (Board)
- CAN Bus Starting and Charging Systems Measurement
- CAN Bus Conventional Starting System Measurement (Board)
- CAN Bus Conventional Charging System Measurement (Board)
- CAN Bus Advanced Starting and Charging System Measurement (Board)
- Automatic Stop-Start System Measurement (Board)
- CAN Bus Power Consumers Measurement (Board)

### Starting and Charging Systems Diagnosis

- CAN Bus Starting and Charging Faults
- CAN Bus Starting and Charging Fault 1 (Board)
- CAN Bus Starting and Charging Fault 2 (Board)
- CAN Bus Starting and Charging Fault 3 (Board)
- CAN Bus Starting and Charging Fault 4 (Board)
- CAN Bus Starting and Charging Fault 5 (Board)
- CAN Bus Starting and Charging Fault 6 (Board)
- CAN Bus Starting and Charging Fault 7 (Board)
- CAN Bus Starting and Charging Fault 8 (Board)

## LIB 3: 52 Automotive Heating and Air Conditioning

### Heating and Air Conditioning Fundamentals

- Air Conditioning Principles
- Air Conditioning Systems
- Air Conditioning Trainer (Auto Rig)
- Air Conditioning Trainer Operation (Auto Rig)
- Refrigeration Cycle (Panel)
- Refrigerant Leak Detection (Panel)

### HVAC Components and Operation

- Compressors
- Lines and Hoses
- Condensers
- Air Distribution Control System Investigation (Panel)
- Air Distribution Control System Troubleshooting 1 (Panel)
- Air Distribution Control System Troubleshooting 2 (Panel)
- Air Distribution Control System Troubleshooting 3 (Panel)
- HVAC Electrical Controls Investigation (Panel)
- A/C Electrical System Fault Investigation (Panel)
- Blower Motor Fault Investigation 1 (Panel)
- Blower Motor Fault Investigation 2 (Panel)
- Compressor Fault Investigation (Panel)
- Climate Control System Operation (Rig)

## HVAC Servicing

- Discharging and Recharging an A/C System (Panel)
- A/C System Troubleshooting 1 (Panel)
- A/C System Troubleshooting 2 (Panel)
- Air Conditioning Practical (Auto Rig)
- Air Conditioning System Performance Test (Auto Rig)
- Inspection and Testing of Airflow Components (Workshop)
- Inspect Airflow Components on a Workshop Vehicle (Workshop)
- Testing Automatic Air Conditioning System Operation (Workshop)
- Cooling System Inspection (Workshop)
- Control Head and Component Servicing (Workshop)
- Heater and Air Management Service Procedure (Workshop)
- Testing For Leaks (Workshop)
- Testing A/C Fail Safe Switches (Workshop)
- Removal, Inspection, and Replacement of A/C Compressor Clutch (Workshop)
- Removing and Replacing the A/C Compressor (Workshop)
- Remove, Inspect, and Install A/C System Hose and Fittings (Workshop)
- Airflow Restrictions and Components (Workshop)
- Replacement and Inspection of Accumulator/Receiver-drier (Workshop)
- Servicing the FOT and TXV (Workshop)
- Inspection of A/C Evaporator Drain (Workshop)
- Filter Inspection and Installation (Workshop)
- A/C Compressor Clutch Removal (Workshop)
- Duratec Engine Air-conditioning System Servicing (Rig)
- Investigation of a FOTCC System (Panel)
- FOTCC System Troubleshooting (Panel)

## LIB 3: 53 Auto Shop

### Automotive Technology

- Automotive Technology

### Shop and Personal Safety

- Rules and Procedures 1
- Rules and Procedures 2
- Ventilation Procedures
- Marked Safety Areas and Evacuation Routes
- Fire Safety Equipment
- Fire Fighting
- First Aid 1
- First Aid 2
- Personal Protective Equipment 1
- Personal Protective Equipment 2
- SRS, EBS, and Hybrid High Voltage Systems
- High Voltage Circuits
- Material Safety Data Sheets

### Preparing Vehicle for Service

- Repair Orders
- The Three Cs (Concern, Cause, and Correction) (Workshop)
- Vehicle Care
- Vehicle Service History
- Logical Fault Diagnosis
- Door Panel Removal and Replacement (Workshop)

### Tools and Equipment

- Tools and Test Equipment
- Tool Usage
- Standard and Metric Designation
- Handling Tools and Equipment
- Handling Tools and Equipment (Workshop)
- Lifting Equipment
- Measuring with a Caliper, Micrometer, or Dial Gauge (Workshop)
- Tool Cleaning, Storage, and Maintenance
- Tool Cleaning, Storage, and Maintenance (Workshop)

### Preparing Vehicle for Customer

- Vehicle Preparation

## LIB 3: 54 Passenger Safety Systems

### SRS Components and Operation

- Airbag Safety
- Introduction to SRS (Rig)
- Airbags (Rig)
- Seat Belts (Rig)

### SRS Inspection and Diagnosis

- Disabling and Enabling the Air Bag System (Workshop)
- SRS Faults (Rig)
- SRS Fault Diagnosis 1 (Rig)
- SRS Fault Diagnosis 2 (Rig)
- SRS Fault Diagnosis 3 (Rig)
- SRS Fault Diagnosis 4 (Rig)
- SRS Fault Diagnosis 5 (Rig)
- SRS Fault Diagnosis 6 (Rig)

## LIB 3: 55 Heavy Vehicle Systems

### CI Engine Components

- HGV Diesel Engine Component Identification (Rig)
- HGV Diesel Engine Cylinders (Rig)
- HGV Diesel Engine Pistons (Rig)
- HGV Diesel Engine Cylinder Head and Valves (Rig)
- HGV Diesel Engine Systems (Rig)

### Engine Management System Fundamentals

- Electronic Control Module - Exercise 2.1
- Cruise Control - Exercise 15.1
- Cruise Control - Worksheet 22
- Cruise Control - Worksheet 23

### Gearbox Components and Operation

- Transmission Construction (Rig)
- HGV Gearbox Operation (Rig)
- HGV Gears and Gear Ratios (Rig)
- Selector Lever, Rail, and Synchronizers (Rig)

### Electronic Controlled Air Suspension

- Electronically Controlled Air Suspension (Rig)
- Electro-pneumatics (Rig)
- Solenoid Valve Unit (Rig)
- Height Sensor (Rig)
- Remote Control Unit (Rig)
- Electronic Controlled Air Suspension Fault Diagnosis 1 (Rig)
- Electronic Controlled Air Suspension Fault Diagnosis 2 (Rig)
- Electronic Controlled Air Suspension Fault Diagnosis 3 (Rig)
- Electronic Controlled Air Suspension Fault Diagnosis 4 (Rig)
- Electronic Controlled Air Suspension Fault Diagnosis 5 (Rig)
- Electronic Controlled Air Suspension Fault Diagnosis 6 (Rig)
- Electronic Controlled Air Suspension Fault Diagnosis 7 (Rig)
- Electronic Controlled Air Suspension Fault Diagnosis 8 (Rig)
- Electronic Controlled Air Suspension Fault Diagnosis 9 (Rig)
- Electronic Controlled Air Suspension Fault Diagnosis 10 (Rig)

## Lighting Systems

- Park, Tail, and Headlamp Circuits 1
- Turn Signal Systems
- Stop and Backup Lamps
- HGV Park, Tail and Headlights - Exercise 9.1
- HGV Park, Tail and Headlights - Worksheet 8
- HGV Turn Signal and Hazard Warning Lights - Exercise 11.1
- HGV Turn Signal and Hazard Warning Lights - Exercise 11.2
- HGV Turn Signal and Hazard Warning Lights - Worksheet 9
- HGV Brake and Backup Lights - Exercise 13.1
- HGV Brake and Backup Lights - Worksheet 10
- HGV Auxiliary Lighting - Exercise 15.1
- HGV Auxiliary Lighting - Worksheet 11

## Auxiliary Electrical Systems

- Battery and Fuses - Exercise 3.1
- Battery and Fuses - Worksheet 1
- Battery and Fuses - Worksheet 2
- Horn and Relays - Exercise 7.1
- Horn and Relays - Worksheet 6
- Horn and Relays - Worksheet 7
- HGV Windshield Wiper System - Exercise 19.1
- HGV Windshield Wiper System - Worksheet 13

## Starting and Charging

- Starting Management, Control, and Regulation
- Starter and Solenoid - Exercise 5.1
- Starter and Solenoid - Worksheet 3
- Starter and Solenoid - Worksheet 4
- Starter and Solenoid - Worksheet 5
- HGV Alternator Charging Systems - Exercise 17.1
- HGV Alternator Charging Systems - Worksheet 12
- HGV Cold Starting Systems - Exercise 21.1
- HGV Cold Starting Systems - Worksheet 14

## Actuators

- Engine Management Actuators - Exercise 18.1
- Engine Management Actuators - Worksheet 24
- Engine Management Actuators - Worksheet 25
- Engine Management Actuators - Worksheet 26
- Engine Management Actuators - Worksheet 27
- Engine Management Actuators - Worksheet 28
- Engine Management Actuators - Worksheet 29
- Engine Management Actuators - Worksheet 30
- Engine Management Actuators - Worksheet 31
- Engine Management Actuators - Worksheet 32

## Sensors

- Engine Protection - Exercise 4.1
- Engine Management Analog Sensors - Exercise 8.1
- Oil Temperature Sensor - Exercise 8.2
- Manifold Air Temperature Sensor - Exercise 8.3
- Oil Pressure Sensor - Exercise 8.4
- Ambient Air Sensor - Exercise 8.5
- Turbo Boost Pressure Sensor - Exercise 8.6
- Throttle Position Sensor - Exercise 8.7
- Engine Management Digital Sensors and Switches - Exercise 10.1
- Engine Management Active Sensors - Exercise 12.1
- Engine Management Analog Sensors - Worksheet 1
- Engine Management Analog Sensors - Worksheet 2
- Engine Management Analog Sensors - Worksheet 3
- Engine Management Analog Sensors - Worksheet 4
- Engine Management Analog Sensors - Worksheet 5
- Engine Management Analog Sensors - Worksheet 6
- Engine Management Analog Sensors - Worksheet 7
- Engine Management Analog Sensors - Worksheet 8
- Engine Management Analog Sensors - Worksheet 9
- Engine Management Analog Sensors - Worksheet 10
- Engine Management Analog Sensors - Worksheet 11
- Engine Management Analog Sensors - Worksheet 12
- Engine Management Analog Sensors - Worksheet 13
- Engine Management Digital Sensors and Switches - Worksheet 14
- Engine Management Digital Sensors and Switches - Worksheet 15
- Engine Management Digital Sensors and Switches - Worksheet 16
- Engine Management Digital Sensors and Switches - Worksheet 17
- Engine Management Digital Sensors and Switches - Worksheet 18
- Engine Management Active Sensors - Worksheet 19
- Engine Management Active Sensors - Worksheet 20
- Engine Management Active Sensors - Worksheet 21

## Diesel Engine Management

- The Fuel Valve - Exercise 18.2
- Fuel Injection - Exercise 18.3
- Injector Pulse Width - Exercise 18.4
- Injector Timing - Exercise 18.5
- Idle Speed Adjustment - Exercise 18.6
- The Fan Clutch - Exercise 18.7
- Engine Exhaust Emissions - Exercise 6.1
- Fuel Injection

## LIB 3: 56 Motorcycle Lighting

### Lamp Circuits

- Using a Multimeter (Board)
- Low and High Beam Headlamps (Board)
- Park / Tail Lamp Circuits (Board)
- Stop Lamps (Board)
- Turn Signal Lamps (Board)
- Park / Tail Lamps and Headlamps (Board)
- Park / Tail Lamp and Headlamp Circuit Assignment (Board)
- Park / Tail Lamps and Relay Controlled Headlamps (Board)
- Instrument Panel Lighting Circuit (Board)

### Relay Circuits

- Relays (Board)
- Relay-Controlled Headlamp Circuit (Board)
- Relay-Controlled Headlamp Flash Circuit (Board)
- Three Pin Relays and Headlamps (Board)
- Four Pin Relays and Headlamps (Board)
- Four Pin Relay Headlamp Circuit Assignment (Board)

### Fault Finding

- Fault Finding (Board)
- Low and High Beam Circuit Fault (Board)
- Park / Tail Lamps Circuit Fault (Board)
- Park / Tail Lamp and Headlamp Circuit Fault (Board)
- Stop Lamp Circuit Fault (Board)
- Turn Signal Circuit Fault (Board)
- Three Pin Relay Headlamp Circuit Fault (Board)
- Four Pin Relay Headlamp Circuit Fault (Board)
- Park / Tail Lamp and Relay Controlled Headlamp Fault (Board)
- Relay-Controlled Headlamp Flash Circuit Fault (Board)

## LIB3: 57 Land Cruiser Complete Vehicle Systems

### Land Cruiser Systems

- Variable Valve Timing (Rig)
- EVAP System Investigation (Rig)
- Land Cruiser Driveline Investigation (Rig)
- Brake System Inspection (Rig)
- Ride Height Measurement (Rig)
- Investigating the Power Windows (Rig)
- Investigating the Door Mirror (Rig)
- Winch Systems
- Military Body Panel Materials

### Land Cruiser Fuel Injection

- Land Cruiser Fuel Injector Pulse Width (Rig)
- Land Cruiser Fuel Injector Pulse Frequency (Rig)
- Land Cruiser Fuel Injector Pulse Timing (Rig)

### Land Cruiser Faults

- Land Cruiser Fault Diagnosis 1 (Rig)
- Land Cruiser Fault Diagnosis 2 (Rig)
- Land Cruiser Fault Diagnosis 3 (Rig)
- Land Cruiser Fault Diagnosis 4 (Rig)
- Land Cruiser Fault Diagnosis 5 (Rig)
- Land Cruiser Fault Diagnosis 6 (Rig)
- Land Cruiser Fault Diagnosis 7 (Rig)
- Land Cruiser Fault Diagnosis 8 (Rig)
- Land Cruiser Fault Diagnosis 9 (Rig)
- Land Cruiser Fault Diagnosis 10 (Rig)

## LIB3: 58 Dynamometers

### Engine Dynamometer Measurements

- Introduction to Dynamometers
- Measuring Air Flow with Variable RPM (CI Engine) (Rig)
- Measuring Air Flow with Variable RPM (SI Engine) (Rig)
- Measuring Cylinder Pressure with Variable RPM (CI Engine) (Rig)
- Measuring Cylinder Pressure with Variable RPM (SI Engine) (Rig)
- Measuring Fuel Use with Variable RPM (CI Engine) (Rig)
- Measuring Fuel Use with Variable RPM (SI Engine) (Rig)
- Measuring Oil Pressure with Variable RPM (CI Engine) (Rig)
- Measuring Oil Pressure with Variable RPM (SI Engine) (Rig)
- Measuring the Effect of Load on Torque (CI Engine) (Rig)
- Measuring the Effect of Load on Torque (SI Engine) (Rig)
- Measuring Torque with Variable RPM (CI Engine) (Rig)
- Measuring Torque with Variable RPM (SI Engine) (Rig)
- Calculating Power with Variable RPM (CI Engine) (Rig)
- Calculating Power with Variable RPM (SI Engine) (Rig)

### Dynamometer Software Analysis

- Introduction to Dynamometer Software
- Analyzing Air Flow with Variable RPM (CI Engine)
- Analyzing Air Flow with Variable RPM (SI Engine)
- Analyzing Torque with Variable RPM (CI Engine)
- Analyzing Torque with Variable RPM (SI Engine)
- Analyzing Power with Variable RPM (CI Engine)
- Analyzing Power with Variable RPM (SI Engine)



# Support

## LIB 3: 59 Engineering Mathematics

### Units of Measure

- Units of Measurement

### Approximation

- Approximations

### Arithmetic

- Multiply Sums
- Adding and Subtracting
- Multiplication and Division of Decimal Numbers

### Fractions

- Fractions - Addition and Subtraction
- Fractions - Multiplication and Division
- Use Fractions
- Simplify Fractions
- Expand Fractions
- Convert Mixed Numbers into Improper Fractions
- Convert Improper Fractions into Mixed Numbers
- Add and Subtract Fractions with the Same Denominator
- Add and Subtract Fractions with Different Denominators
- Convert Fractions to Decimal Numbers
- Convert Decimal Numbers to Fractions

### Percentages

- Percentages (Part of 100)
- Percentages
- Calculate Percentages of Values
- Calculate Percentage Increases
- Calculate Percentage Reductions
- Parts per Thousand

### Length, Area and Volume

- Lengths, Surface Area and Volume
- Lengths, Units and Prefixes
- Calculate the Perimeter of a Rectangle
- Calculate the Area of a Rectangle
- Calculate the Area of a Complex Shape
- Calculate Volume

### Graphs and Charts

- Graphs - Straight Line Graphs
- Graphs - Square Law
- Graphs - Pie Chart

### Equations

- Transposing Equations
- Performing Calculations
- Sign Rules for Mathematical Operations
- Distributive Law
- Multiply Out Brackets
- Structure Equations
- Transform Equations by Addition and Subtraction
- Transform Equations by Multiplication and Division
- Transpose Equations
- Calculate the Unknown Variable in an Equation
- Equating Method for Solving Simultaneous Equations
- Addition Method for Solving Simultaneous Equations

### Algebra

- Algebra - Simple Formula
- First, Second, and Third Order Brackets
- Rule of Three (Direct Proportion)
- Rule of Three (Inverse Proportion)

### Factorization

- Simple Factorization

### Indices

- Working with Powers and Standard Form
- Indices - Powers of 10
- Indices - Addition and Subtraction
- Indices - Multiplication and Division
- Indices - Letter Notation
- Powers
- Indices
- Square Roots

### Angles

- Angular Measure
- Measuring Angles
- Calculating with Angles

## Trigonometry

- Lengths and Pythagoras' Theorem
- Pythagoras' Theorem
- Basic Trigonometry

## Number Systems

- Binary and Decimal Conversions

## Phasors

- Phase Angles
- Phasor Diagrams

# LIB 3: 60 English Language Skills

## Language

- Language Acquisition

## Reading

- Citing Strong and Thorough Evidence
- Identifying and Analyzing Ideas in a Text
- Understanding and Interpreting a Text
- Understanding the Different Meanings of Language
- Understanding the Structure of a Text
- Determining a Writer's Perspective
- Understanding Multiple Sources of Information
- Evaluating Arguments and Specific Claims Made in a Text

## Speaking and Listening

- Planning, Writing, Presenting, and Evaluating
- Discussing Different Perspectives
- Justifying Decisions with Reasoning
- Engaging in Group Discussions
- Presenting a Perspective to an Audience
- Speak on the Telephone
- How to Introduce Yourself
- Listening and Understanding
- Engage in a Two-Way Conversation

## Writing

- Arguing a Perspective
- Presenting a Persuasive Perspective
- Formal Letters with a Perspective
- Creating an Informative Text
- Informing an Audience
- Writing an Informative Article
- Understanding and Using Perspective in a Narrative
- Writing Reality as a Narrative
- Writing History

## LIB 3: 61 Business Skills

### Fundamentals of Business Organization

- Corporate Mission and Goals
- Business Organizational Structure
- Quality and Environmental Management
- Business Process Optimization

### Financial Accounting and Bookkeeping

- The Inventory
- Purchase Cost Calculations
- Balance Sheet Changes
- Balance Sheet Accounting
- Profit and Loss Accounts
- Inventory Accounting: The Perpetual Method
- Inventory Accounting: The Periodic Method
- List Price Determination
- Accruals and Pre-Payments
- Accounting - Valuation Principles
- Valuation of Balance Sheet Items

### Production

- Production Management
- Analytical Techniques
- Product Range
- Product Range Development
- Production Planning
- Production Process Planning
- Production Process Control
- Improving Production
- Quality Control
- Controlling Production

### Cost Accounting

- Marginal Cost Calculations

### Economics

- Economic Systems
- Economic Flow Models
- Economic Measures
- Monetary Policy and Price Level Stability
- Production Factors
- Location Factors
- Pricing and Types of Markets
- Needs, Wants and Demand

### Procurement

- Management of Hazardous Substances
- Stock Control and the Production Process
- Organizing Procurement
- Material Requirements Planning (MRP)
- Purchasing Calculations
- Monitoring Purchasing
- International Commercial Terms and Contracts
- Warehousing
- Controlling Procurement
- Material Procurement

### Sales and Marketing

- Marketing Planning
- Product and the Marketing Mix
- Pricing Strategies
- Advertising and the Marketing Mix
- Communications and the Marketing Mix
- Distribution and the Marketing Mix
- Control of the Customer's Order
- Sales and Marketing Measures

### Social Skills

- Punctuality
- Dress Code
- Personal Space
- Handle Collective Property
- Common Courtesies

### Legal Framework

- Types of Contracts
- Process Chains and Networks
- Breach of Contract
- Contracts and UN Law

### Investment and Financing

- Investment Planning
- Investment Analysis
- Financing Rules
- Internal Financing
- Profit and Loss Analysis
- External Financing
- The Financial Plan and Leasing

# LIB 3: 62 Freight Logistics

## Basics of Storage

- The Organization of Storage
- Storage and Warehouse Technology

## Storage of Goods

- The Storage of Different Types of Goods
- Storage and Retrieval Criteria
- Storage Costs
- Storage Issues

## Picking Stock

- Organization of Picking
- Key Figures of Picking

## Packaged Goods

- Packaging
- Packaging Aids
- Packaging of Goods

## Efficiency and Optimization of the Warehouse

- Storage Indicators
- Quality Management in the Warehouse

## Loading

- Loading Goods Overview

## Internal Transport and Loading

- Securing Loads
- Conveying
- Picking Vehicles and Lifting Equipment
- Loading Systems
- Internal Transport and Loading Overview
- Unloading Goods

## Human Resources

- Accident Prevention in the Warehouse
- Handling of Hazardous Materials

## Route Planning

- Legal Regulations for Shipping
- Freight Costs
- Event Driven Process Chain for Route Planning
- Transporting Hazardous Materials
- Accompanying Documents

## Stowage Planning

- Stowage Calculations
- Planning for Stowage
- Stowage Planning for Dangerous Goods

## Event Driven Process Chains

- EPC Diagrams

## Information Processing

- The Network
- The Intranet and Internet
- Privacy Policy
- The Workstation Computer

## LIB 3: 63 Workplace Problem Solving

### Production

- Running a Bicycle Parts Production Line
- Running Two Production Lines for Bicycle Parts
- Paint Mixing - Calculating Materials
- Machine Productivity for Cutting Metal Shapes
- Mass Production - Calculating Quantities
- Comparing Machine Productivities
- Choosing Packaging for Parts
- Calculating Costs in a Food Factory
- Programming a Drinks Bottling Plant
- Setting Up a Paint Filling Machine

### Distribution

- Calculating Shipping Costs
- Planning Logistics

### Construction

- Car Park Construction - Calculating Materials
- Perimeter Fencing - Calculating Materials
- Installing a Flag Pole
- Tiling a Bathroom Floor

### Sales and Marketing

- Sales Conversion - Calculating Rates
- Calculating Sales Discounts

### Finance

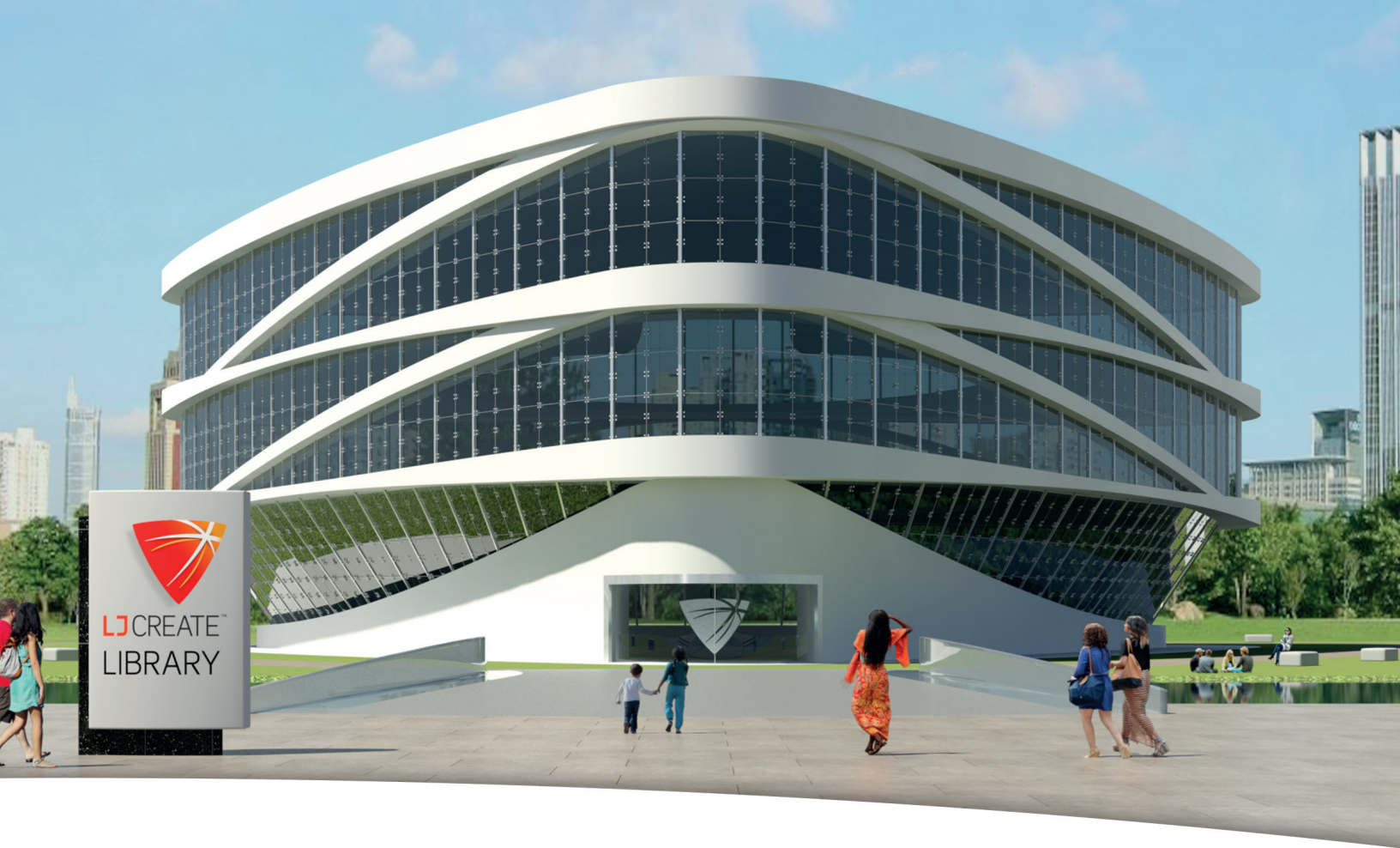
- Upgrading a Vehicle Fleet
- Phone Contracts - Comparing Deals
- Calculating Costs for a Building Project
- Comparing Crane Hire Costs
- Calculating Stationery Costs
- Calculating VAT Rates

### Customer Service

- Handling a Telephone Call

### Human Resources

- Visiting a Construction Site
- Improving the Workplace
- Attending a Meeting
- Choosing a Computer Monitor
- Workforce Planning



For more information on our range of learning resources, please contact:

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