

RV Power, Controls & Integrated Systems Engineering

MRR-RV225 | 15 weeks | 5 proposed semester credits | 45 lecture + 30 lab + 150 independent hours

Original independent curriculum proposal for institutional review only. MRR is not claiming state approval, institutional accreditation, GRCC articulation or award of college credit, an RVTI affiliation, or RVTI exam authorization. Credit, accreditation, industry certification and instructor eligibility require separate written decisions by the appropriate organizations.

Safety:

Exercises rely on inert demonstration devices, de-energized schematics, current-limited low-voltage trainers, simulated records, or manufacturer literature. A course webpage is not a license to manipulate LP-gas piping, energized 120/240-volt systems, generators, refrigerants, roof-access systems, brakes, hitches, jacks, or safety-critical structural parts. Practical work requires qualified supervision, an appropriate facility and documented stop-work authority.

Prerequisite: MRR-RV215 or documented comparable background in diagnostics, applied electrical theory, measurement and safe laboratory practice.

Student learning outcomes

- Translate user needs into measurable RV system requirements, constraints and acceptance criteria.
- Model power, control, thermal and mechanical subsystems using basic engineering calculations and uncertainty analysis.
- Compare component architectures using efficiency, protection, manufacturability and lifecycle trade-offs.
- Implement and characterize an instructor-approved low-energy demonstrator using safe bench supplies and mock loads.
- Defend a design verification and validation plan using reproducible test records and technical sources.

Seminar practice and assessment

For every technical model, include quantitative assumptions, relevant source documents, units, uncertainty, a falsifying test, and scope limitations. Instructors evaluate lab performance in supervised facilities; online checkboxes do not record academic credit.

Proposed workload

Each week: 3 lecture hours, 2 supervised laboratory hours, 10 hours of independent reading, calculations, technical writing and peer critique. Over 15 weeks: 45 lecture, 30 lab, 150 independent; total 225 planned learning hours.

Academic integrity

All case records and numeric exercises are original fictional teaching scenarios, not service records. Student reports must label synthetic values, credit technical sources and avoid falsified test evidence.

WEEK 01 | Systems engineering, requirements and acceptance criteria

Lecture / theoretical framework

A successful design starts with requirements rather than vendor selections. Translate user stories into measurable performance, safety, maintenance and environmental specifications. Distinguish verification of a requirement from validation that the requirement addresses the actual customer need. Establish interface boundaries and a traceability matrix.

The analytical objective is to justify the chosen system boundary and explain which variables were omitted. Develop an independent cross-check for the proposed interpretation, and distinguish an observed event from a confirmed causal mechanism. A single reading rarely justifies a hardware replacement; build an evidence hierarchy and show a test that could invalidate the initial diagnosis.

Synthetic case study

A mobile field-service trailer needs power for controls and refrigeration without relying on shore power.

Present competing hypotheses, severity-first hazards, and a source-backed diagnostic plan that does not exceed permitted supervision. Explain a plausible alternative that would result in a different repair decision.

Quantitative problem

If daily demand is 1.8 kWh and required autonomy is 2.5 days, what load-side storage energy is required before conversion losses?

Explain the derivation, units, order-of-magnitude reasonableness, assumptions and at least one sensitivity variation. Worked solutions are reserved for the faculty answer key.

Supervised laboratory

Use a paper design review and a simulated low-voltage load table; develop a requirement-to-test traceability matrix.

Required record: objective; protected/inert equipment configuration; data table and units; limitations; instructor sign-off; hazard and stop-work statement.

Ten-hour independent research assignment

Write a 2,000-word requirements specification including failure conditions, safety stop criteria and test acceptance limits.

Recommended distribution: four hours of source reading and technical verification, three hours of numerical/model work, and three hours of technical writing and revision.

Source evaluation

INCOSE-style requirements; equipment datasheets; manufacturer application notes.

For research, use relevant manufacturer manuals and technical standards with current edition and jurisdiction verified. Disclose if the evidence is simulated or a generic estimate.

Seminar questions

1. What observation could disprove the current leading hypothesis?
2. Which risk would make continuation inappropriate even if a model predicts successful repair?
3. What primary-source specification must be obtained before a technician can act?

WEEK 02 | Electrical load profiles and demand diversity

Lecture / theoretical framework

A single peak-load number cannot characterize energy use. Separate standby, recurring, seasonal, surge and intermittent loads and identify demand diversity. Calculate energy by integration of power over time. Analyze variability and load shedding choices before sizing generation or storage.

The analytical objective is to justify the chosen system boundary and explain which variables were omitted. Develop an independent cross-check for the proposed interpretation, and distinguish an observed event from a confirmed causal mechanism. A single reading rarely justifies a hardware replacement; build an evidence hierarchy and show a test that could invalidate the initial diagnosis.

Synthetic case study

A mobile RV medical-support scenario has a continuous 38 W load, a 150 W load for 2 h/day and a 900 W load for 8 min/day.

Present competing hypotheses, severity-first hazards, and a source-backed diagnostic plan that does not exceed permitted supervision. Explain a plausible alternative that would result in a different repair decision.

Quantitative problem

Calculate nominal daily energy without conversion losses.

Explain the derivation, units, order-of-magnitude reasonableness, assumptions and at least one sensitivity variation. Worked solutions are reserved for the faculty answer key.

Supervised laboratory

Integrate a supplied 24-hour power series and compare to a peak-watt-only design.

Required record: objective; protected/inert equipment configuration; data table and units; limitations; instructor sign-off; hazard and stop-work statement.

Ten-hour independent research assignment

Submit a diversified energy budget and sensitivity analysis for duty cycle and seasonal variation.

Recommended distribution: four hours of source reading and technical verification, three hours of numerical/model work, and three hours of technical writing and revision.

Source evaluation

Load profiling; power-system planning; device nameplate limitations.

For research, use relevant manufacturer manuals and technical standards with current edition and jurisdiction verified. Disclose if the evidence is simulated or a generic estimate.

Seminar questions

1. What observation could disprove the current leading hypothesis?
2. Which risk would make continuation inappropriate even if a model predicts successful repair?
3. What primary-source specification must be obtained before a technician can act?

WEEK 03 | Photovoltaics, charge control and solar resource uncertainty

Lecture / theoretical framework

Photovoltaic systems require realistic irradiance, orientation, temperature and shading assumptions. A controller rating alone does not predict daily energy. Compare MPPT and PWM conceptual trade-offs and validate that all equipment limits and interconnections require qualified design verification.

The analytical objective is to justify the chosen system boundary and explain which variables were omitted. Develop an independent cross-check for the proposed interpretation, and distinguish an observed event from a confirmed causal mechanism. A single reading rarely justifies a hardware replacement; build an evidence hierarchy and show a test that could invalidate the initial diagnosis.

Synthetic case study

A proposed rooftop panel array has 550 W nominal capacity but shading during a significant fraction of daylight.

Present competing hypotheses, severity-first hazards, and a source-backed diagnostic plan that does not exceed permitted supervision. Explain a plausible alternative that would result in a different repair decision.

Quantitative problem

At an assumed 3.5 equivalent full-sun hours and 78% combined performance factor, estimate daily energy.

Explain the derivation, units, order-of-magnitude reasonableness, assumptions and at least one sensitivity variation. Worked solutions are reserved for the faculty answer key.

Supervised laboratory

Use a spreadsheet solar model and controlled shading dataset; no rooftop electrical work.

Required record: objective; protected/inert equipment configuration; data table and units; limitations; instructor sign-off; hazard and stop-work statement.

Ten-hour independent research assignment

Produce a shading sensitivity plot and a procurement decision memo with stated uncertainty.

Recommended distribution: four hours of source reading and technical verification, three hours of numerical/model work, and three hours of technical writing and revision.

Source evaluation

Solar resource models; panel and controller OEM documentation.

For research, use relevant manufacturer manuals and technical standards with current edition and jurisdiction verified. Disclose if the evidence is simulated or a generic estimate.

Seminar questions

1. What observation could disprove the current leading hypothesis?
2. Which risk would make continuation inappropriate even if a model predicts successful repair?
3. What primary-source specification must be obtained before a technician can act?

WEEK 04 | Battery systems, protection and thermal design

Lecture / theoretical framework

A battery is an electrochemical system with defined operating envelopes rather than a passive energy container. Study battery-management system limits, temperature effects, current transients and fault containment at the conceptual level. Manufacturer charge settings and protective device requirements constrain any proposed architecture.

The analytical objective is to justify the chosen system boundary and explain which variables were omitted. Develop an independent cross-check for the proposed interpretation, and distinguish an observed event from a confirmed causal mechanism. A single reading rarely justifies a hardware replacement; build an evidence hierarchy and show a test that could invalidate the initial diagnosis.

Synthetic case study

A lithium battery operates well at room temperature but refuses to charge in freezing weather.

Present competing hypotheses, severity-first hazards, and a source-backed diagnostic plan that does not exceed permitted supervision. Explain a plausible alternative that would result in a different repair decision.

Quantitative problem

A nominal 48 V, 100 Ah battery has 90% usable capacity. Find nominal usable energy before other losses.

Explain the derivation, units, order-of-magnitude reasonableness, assumptions and at least one sensitivity variation. Worked solutions are reserved for the faculty answer key.

Supervised laboratory

Analyze simulated temperature and current traces; compare trip patterns and safe design alternatives.

Required record: objective; protected/inert equipment configuration; data table and units; limitations; instructor sign-off; hazard and stop-work statement.

Ten-hour independent research assignment

Build a fault-and-limit register explaining BMS protection and customer-facing warnings.

Recommended distribution: four hours of source reading and technical verification, three hours of numerical/model work, and three hours of technical writing and revision.

Source evaluation

Battery OEM operating limitations; thermal management; applicable electrical safety norms.

For research, use relevant manufacturer manuals and technical standards with current edition and jurisdiction verified. Disclose if the evidence is simulated or a generic estimate.

Seminar questions

1. What observation could disprove the current leading hypothesis?
2. Which risk would make continuation inappropriate even if a model predicts successful repair?
3. What primary-source specification must be obtained before a technician can act?

WEEK 05 | AC power architecture and source transfer

Lecture / theoretical framework

Shore power, inverters and generators can create overlapping energy sources. Study block-level transfer architecture and interlock requirements without performing energization, rewiring or transfer-switch service. Analyze consequences of source conflicts and protective device coordination using manufacturer diagrams.

The analytical objective is to justify the chosen system boundary and explain which variables were omitted. Develop an independent cross-check for the proposed interpretation, and distinguish an observed event from a confirmed causal mechanism. A single reading rarely justifies a hardware replacement; build an evidence hierarchy and show a test that could invalidate the initial diagnosis.

Synthetic case study

A user reports power flicker when a generator starts while a DC accessory remains stable.

Present competing hypotheses, severity-first hazards, and a source-backed diagnostic plan that does not exceed permitted supervision. Explain a plausible alternative that would result in a different repair decision.

Quantitative problem

Two sequential energy conversions are 92% and 88% efficient. What is overall efficiency?

Explain the derivation, units, order-of-magnitude reasonableness, assumptions and at least one sensitivity variation. Worked solutions are reserved for the faculty answer key.

Supervised laboratory

Trace a de-energized source-selection mockup and identify prohibited states in a truth table.

Required record: objective; protected/inert equipment configuration; data table and units; limitations; instructor sign-off; hazard and stop-work statement.

Ten-hour independent research assignment

Prepare a functional safety analysis and verification checklist for qualified reviewers.

Recommended distribution: four hours of source reading and technical verification, three hours of numerical/model work, and three hours of technical writing and revision.

Source evaluation

NEC Article 551 and related standards as applicable; OEM ATS manuals.

For research, use relevant manufacturer manuals and technical standards with current edition and jurisdiction verified. Disclose if the evidence is simulated or a generic estimate.

Seminar questions

1. What observation could disprove the current leading hypothesis?
2. Which risk would make continuation inappropriate even if a model predicts successful repair?
3. What primary-source specification must be obtained before a technician can act?

WEEK 06 | Grounding, bonding and system protection reasoning

Lecture / theoretical framework

Fault clearing and touch-voltage control depend on equipment grounding, bonding and correctly coordinated protection, not simply the presence of a green wire. Use source/return and fault-path diagrams to locate conceptual hazards. Do not test live AC distribution, neutral bonding or grounding in customer equipment as a student activity.

The analytical objective is to justify the chosen system boundary and explain which variables were omitted. Develop an independent cross-check for the proposed interpretation, and distinguish an observed event from a confirmed causal mechanism. A single reading rarely justifies a hardware replacement; build an evidence hierarchy and show a test that could invalidate the initial diagnosis.

Synthetic case study

A hypothetical wiring drawing includes an added neutral-ground bond downstream of an RV source transfer point.

Present competing hypotheses, severity-first hazards, and a source-backed diagnostic plan that does not exceed permitted supervision. Explain a plausible alternative that would result in a different repair decision.

Quantitative problem

With 10 A through a 0.08-ohm unintended connection, compute voltage drop and dissipated power in an illustrative model.

Explain the derivation, units, order-of-magnitude reasonableness, assumptions and at least one sensitivity variation. Worked solutions are reserved for the faculty answer key.

Supervised laboratory

Critique three inert wiring schematics, identifying assumptions to be verified by licensed or qualified electrical personnel.

Required record: objective; protected/inert equipment configuration; data table and units; limitations; instructor sign-off; hazard and stop-work statement.

Ten-hour independent research assignment

Write a protective architecture review with exact source citations, not invented code quotations.

Recommended distribution: four hours of source reading and technical verification, three hours of numerical/model work, and three hours of technical writing and revision.

Source evaluation

Current applicable NEC, RV manufacturer data, electrical safety standards.

For research, use relevant manufacturer manuals and technical standards with current edition and jurisdiction verified. Disclose if the evidence is simulated or a generic estimate.

Seminar questions

1. What observation could disprove the current leading hypothesis?
2. Which risk would make continuation inappropriate even if a model predicts successful repair?
3. What primary-source specification must be obtained before a technician can act?

WEEK 07 | Sensors, instrumentation and control-loop stability

Lecture / theoretical framework

Signal quality, sensor calibration, control latency and actuator limits affect system behavior. Introduce open- and closed-loop concepts, proportional feedback and the risks of control overshoot. An observed oscillation might arise from sensor filtering or system inertia rather than a defective controller.

The analytical objective is to justify the chosen system boundary and explain which variables were omitted. Develop an independent cross-check for the proposed interpretation, and distinguish an observed event from a confirmed causal mechanism. A single reading rarely justifies a hardware replacement; build an evidence hierarchy and show a test that could invalidate the initial diagnosis.

Synthetic case study

A thermal controller alternates rapidly between heating and off during mild weather.

Present competing hypotheses, severity-first hazards, and a source-backed diagnostic plan that does not exceed permitted supervision. Explain a plausible alternative that would result in a different repair decision.

Quantitative problem

A controller samples every 250 ms. What is its sampling rate?

Explain the derivation, units, order-of-magnitude reasonableness, assumptions and at least one sensitivity variation. Worked solutions are reserved for the faculty answer key.

Supervised laboratory

Use a low-energy educational controller simulator to vary gain and observe overshoot without energizing heaters.

Required record: objective; protected/inert equipment configuration; data table and units; limitations; instructor sign-off; hazard and stop-work statement.

Ten-hour independent research assignment

Analyze plotted time-series with overshoot, settling time and stability observations.

Recommended distribution: four hours of source reading and technical verification, three hours of numerical/model work, and three hours of technical writing and revision.

Source evaluation

Feedback control fundamentals; sensor manuals; signal acquisition texts.

For research, use relevant manufacturer manuals and technical standards with current edition and jurisdiction verified. Disclose if the evidence is simulated or a generic estimate.

Seminar questions

1. What observation could disprove the current leading hypothesis?
2. Which risk would make continuation inappropriate even if a model predicts successful repair?
3. What primary-source specification must be obtained before a technician can act?

WEEK 08 | Actuation, mechanisms and mechanical energy

Lecture / theoretical framework

Power train design couples motor torque, gearing, friction and duty cycle. Evaluate mechanical limits and interlocks of slide-out and leveling models; identify pinch, crush and stored-energy hazards. An educational demonstrator should use low forces and a physical emergency stop.

The analytical objective is to justify the chosen system boundary and explain which variables were omitted. Develop an independent cross-check for the proposed interpretation, and distinguish an observed event from a confirmed causal mechanism. A single reading rarely justifies a hardware replacement; build an evidence hierarchy and show a test that could invalidate the initial diagnosis.

Synthetic case study

A lift mockup needs 45 N of force at a lever arm of 0.12 m under a simplified static model.

Present competing hypotheses, severity-first hazards, and a source-backed diagnostic plan that does not exceed permitted supervision. Explain a plausible alternative that would result in a different repair decision.

Quantitative problem

Estimate required torque before friction and safety factors.

Explain the derivation, units, order-of-magnitude reasonableness, assumptions and at least one sensitivity variation. Worked solutions are reserved for the faculty answer key.

Supervised laboratory

Model a low-force mechanism with transparent load limits and compare theoretical to measured torque.

Required record: objective; protected/inert equipment configuration; data table and units; limitations; instructor sign-off; hazard and stop-work statement.

Ten-hour independent research assignment

Produce a mechanism risk register and an actuator-selection justification supported by supplier curves.

Recommended distribution: four hours of source reading and technical verification, three hours of numerical/model work, and three hours of technical writing and revision.

Source evaluation

Statics; motor datasheets; manufacturer mechanical safety literature.

For research, use relevant manufacturer manuals and technical standards with current edition and jurisdiction verified. Disclose if the evidence is simulated or a generic estimate.

Seminar questions

1. What observation could disprove the current leading hypothesis?
2. Which risk would make continuation inappropriate even if a model predicts successful repair?
3. What primary-source specification must be obtained before a technician can act?

WEEK 09 | Structures, joints and fatigue in mobile environments

Lecture / theoretical framework

Vibration and cyclic loads make one-time strength calculations incomplete. Consider fatigue, joining method, environmental exposure, stress concentration and inspectability. Student projects are nonstructural only; no welding on RV lift posts, hitches, chassis or other safety-critical structures without qualified engineering and approved procedures.

The analytical objective is to justify the chosen system boundary and explain which variables were omitted. Develop an independent cross-check for the proposed interpretation, and distinguish an observed event from a confirmed causal mechanism. A single reading rarely justifies a hardware replacement; build an evidence hierarchy and show a test that could invalidate the initial diagnosis.

Synthetic case study

A nonstructural storage bracket has cracked near a sharp interior corner after extended travel.

Present competing hypotheses, severity-first hazards, and a source-backed diagnostic plan that does not exceed permitted supervision. Explain a plausible alternative that would result in a different repair decision.

Quantitative problem

An illustrative cyclic load varies from 80 to 160 N. Compute load amplitude and mean.

Explain the derivation, units, order-of-magnitude reasonableness, assumptions and at least one sensitivity variation. Worked solutions are reserved for the faculty answer key.

Supervised laboratory

Compare deflection on inert nonstructural coupons with different corner geometries.

Required record: objective; protected/inert equipment configuration; data table and units; limitations; instructor sign-off; hazard and stop-work statement.

Ten-hour independent research assignment

Write a fatigue-risk explanation distinguishing static design capacity from cyclic performance.

Recommended distribution: four hours of source reading and technical verification, three hours of numerical/model work, and three hours of technical writing and revision.

Source evaluation

Fatigue fundamentals; supplier ratings; materials texts.

For research, use relevant manufacturer manuals and technical standards with current edition and jurisdiction verified. Disclose if the evidence is simulated or a generic estimate.

Seminar questions

1. What observation could disprove the current leading hypothesis?
2. Which risk would make continuation inappropriate even if a model predicts successful repair?
3. What primary-source specification must be obtained before a technician can act?

WEEK 10 | Thermal management and heat exchanger selection

Lecture / theoretical framework

Thermal performance depends on airflow, heat transfer resistance, humidity and control behavior. Simplified first-law calculations are useful but their assumptions must be declared. Compare total system demand with component ratings, accounting for solar gain and thermal infiltration.

The analytical objective is to justify the chosen system boundary and explain which variables were omitted. Develop an independent cross-check for the proposed interpretation, and distinguish an observed event from a confirmed causal mechanism. A single reading rarely justifies a hardware replacement; build an evidence hierarchy and show a test that could invalidate the initial diagnosis.

Synthetic case study

A small insulated test chamber receives a known heater input, but wall losses are uncertain.

Present competing hypotheses, severity-first hazards, and a source-backed diagnostic plan that does not exceed permitted supervision. Explain a plausible alternative that would result in a different repair decision.

Quantitative problem

A 250 W load runs for 2.4 hours. How much energy does it add?

Explain the derivation, units, order-of-magnitude reasonableness, assumptions and at least one sensitivity variation. Worked solutions are reserved for the faculty answer key.

Supervised laboratory

Analyze an instructor-provided chamber dataset and infer an effective heat-loss coefficient without opening refrigeration circuits.

Required record: objective; protected/inert equipment configuration; data table and units; limitations; instructor sign-off; hazard and stop-work statement.

Ten-hour independent research assignment

Submit a thermal model, residual chart and limits-to-validity paragraph.

Recommended distribution: four hours of source reading and technical verification, three hours of numerical/model work, and three hours of technical writing and revision.

Source evaluation

Heat transfer; insulation technical data; HVAC equipment performance curves.

For research, use relevant manufacturer manuals and technical standards with current edition and jurisdiction verified. Disclose if the evidence is simulated or a generic estimate.

Seminar questions

1. What observation could disprove the current leading hypothesis?
2. Which risk would make continuation inappropriate even if a model predicts successful repair?
3. What primary-source specification must be obtained before a technician can act?

WEEK 11 | Appliance systems integration and environmental loads

Lecture / theoretical framework

Appliances must be evaluated as part of system demand rather than independent catalog choices. Ventilation, duty cycle, load priority and adverse operating conditions can interact. System integration is a design problem involving interfaces, access for service and protection against single-point failures.

The analytical objective is to justify the chosen system boundary and explain which variables were omitted. Develop an independent cross-check for the proposed interpretation, and distinguish an observed event from a confirmed causal mechanism. A single reading rarely justifies a hardware replacement; build an evidence hierarchy and show a test that could invalidate the initial diagnosis.

Synthetic case study

Refrigeration performs adequately on shore power but competes with battery charging after dusk.

Present competing hypotheses, severity-first hazards, and a source-backed diagnostic plan that does not exceed permitted supervision. Explain a plausible alternative that would result in a different repair decision.

Quantitative problem

A 90 W compressor operates 55% of a day; estimate daily demand.

Explain the derivation, units, order-of-magnitude reasonableness, assumptions and at least one sensitivity variation. Worked solutions are reserved for the faculty answer key.

Supervised laboratory

Build a simulated load-priority controller model with strictly low-voltage indicator loads.

Required record: objective; protected/inert equipment configuration; data table and units; limitations; instructor sign-off; hazard and stop-work statement.

Ten-hour independent research assignment

Write an interface-control document showing all energy and control connections.

Recommended distribution: four hours of source reading and technical verification, three hours of numerical/model work, and three hours of technical writing and revision.

Source evaluation

OEM appliance requirements; energy systems design; thermal performance standards.

For research, use relevant manufacturer manuals and technical standards with current edition and jurisdiction verified. Disclose if the evidence is simulated or a generic estimate.

Seminar questions

1. What observation could disprove the current leading hypothesis?
2. Which risk would make continuation inappropriate even if a model predicts successful repair?
3. What primary-source specification must be obtained before a technician can act?

WEEK 12 | Custom components, 3D printing and serviceability

Lecture / theoretical framework

Additive fabrication should begin with failure consequence and material suitability, not visual resemblance. Describe tolerance stacks, creep, UV exposure, temperature limits, anisotropy and inspection criteria. For high-consequence or load-bearing parts, replacement must follow approved manufacturer or engineered methods.

The analytical objective is to justify the chosen system boundary and explain which variables were omitted. Develop an independent cross-check for the proposed interpretation, and distinguish an observed event from a confirmed causal mechanism. A single reading rarely justifies a hardware replacement; build an evidence hierarchy and show a test that could invalidate the initial diagnosis.

Synthetic case study

A discontinued cosmetic trim clip fractures after summer heat exposure.

Present competing hypotheses, severity-first hazards, and a source-backed diagnostic plan that does not exceed permitted supervision. Explain a plausible alternative that would result in a different repair decision.

Quantitative problem

A nominal clip width is 18.0 ± 0.3 mm and slot width 18.5 ± 0.2 mm. Compute worst-case clearance.

Explain the derivation, units, order-of-magnitude reasonableness, assumptions and at least one sensitivity variation. Worked solutions are reserved for the faculty answer key.

Supervised laboratory

Measure inert printed coupons along and across build directions and compare dimensions.

Required record: objective; protected/inert equipment configuration; data table and units; limitations; instructor sign-off; hazard and stop-work statement.

Ten-hour independent research assignment

Produce a nonstructural design history file with materials justification, tolerance, environmental risks and rejection rules.

Recommended distribution: four hours of source reading and technical verification, three hours of numerical/model work, and three hours of technical writing and revision.

Source evaluation

Additive manufacturing process principles; materials datasheets; OEM component specifications.

For research, use relevant manufacturer manuals and technical standards with current edition and jurisdiction verified. Disclose if the evidence is simulated or a generic estimate.

Seminar questions

1. What observation could disprove the current leading hypothesis?
2. Which risk would make continuation inappropriate even if a model predicts successful repair?
3. What primary-source specification must be obtained before a technician can act?

WEEK 13 | Subsystem prototype and low-energy integration

Lecture / theoretical framework

Integration introduces faults absent in isolated subsystems: incompatible logic levels, cumulative voltage drops and uncontrolled startup states. Require a staged commissioning plan with test gates. Prototype work should use current-limited supplies, fuses and mock loads—never field-commission a hazardous system as part of this course.

The analytical objective is to justify the chosen system boundary and explain which variables were omitted. Develop an independent cross-check for the proposed interpretation, and distinguish an observed event from a confirmed causal mechanism. A single reading rarely justifies a hardware replacement; build an evidence hierarchy and show a test that could invalidate the initial diagnosis.

Synthetic case study

A sensor board and DC motor driver work independently but fail when connected to a shared power source.

Present competing hypotheses, severity-first hazards, and a source-backed diagnostic plan that does not exceed permitted supervision. Explain a plausible alternative that would result in a different repair decision.

Quantitative problem

At 3 A, a return wire has 0.12 ohm resistance. Estimate return-line drop.

Explain the derivation, units, order-of-magnitude reasonableness, assumptions and at least one sensitivity variation. Worked solutions are reserved for the faculty answer key.

Supervised laboratory

Integrate approved 5 V/12 V trainer modules with simulated loads and an instructor-defined shutdown test.

Required record: objective; protected/inert equipment configuration; data table and units; limitations; instructor sign-off; hazard and stop-work statement.

Ten-hour independent research assignment

Submit circuit and interface drawings, test log, unexpected outcomes and corrective action evidence.

Recommended distribution: four hours of source reading and technical verification, three hours of numerical/model work, and three hours of technical writing and revision.

Source evaluation

Systems integration test methods; instrumentation guides; vendor application notes.

For research, use relevant manufacturer manuals and technical standards with current edition and jurisdiction verified. Disclose if the evidence is simulated or a generic estimate.

Seminar questions

1. What observation could disprove the current leading hypothesis?
2. Which risk would make continuation inappropriate even if a model predicts successful repair?
3. What primary-source specification must be obtained before a technician can act?

WEEK 14 | Verification, validation and configuration management

Lecture / theoretical framework

Verification asks whether requirements were satisfied; validation asks whether the solution meets the intended need. A design can pass its internal test and still fail the user. Configuration control makes results reproducible: part number, firmware, revision, test procedure and data provenance must be recorded.

The analytical objective is to justify the chosen system boundary and explain which variables were omitted. Develop an independent cross-check for the proposed interpretation, and distinguish an observed event from a confirmed causal mechanism. A single reading rarely justifies a hardware replacement; build an evidence hierarchy and show a test that could invalidate the initial diagnosis.

Synthetic case study

A prototype passes lab checks but fails in high summer humidity after customer installation.

Present competing hypotheses, severity-first hazards, and a source-backed diagnostic plan that does not exceed permitted supervision. Explain a plausible alternative that would result in a different repair decision.

Quantitative problem

Of 48 scripted tests, 45 pass, 2 fail and 1 is blocked. Report pass share for executed tests.

Explain the derivation, units, order-of-magnitude reasonableness, assumptions and at least one sensitivity variation. Worked solutions are reserved for the faculty answer key.

Supervised laboratory

Conduct document-based verification audit for simulated prototype revisions.

Required record: objective; protected/inert equipment configuration; data table and units; limitations; instructor sign-off; hazard and stop-work statement.

Ten-hour independent research assignment

Write a requirements traceability matrix with pass, fail, blocked and not-tested statuses.

Recommended distribution: four hours of source reading and technical verification, three hours of numerical/model work, and three hours of technical writing and revision.

Source evaluation

Design assurance; configuration management; evidence-based verification.

For research, use relevant manufacturer manuals and technical standards with current edition and jurisdiction verified. Disclose if the evidence is simulated or a generic estimate.

Seminar questions

1. What observation could disprove the current leading hypothesis?
2. Which risk would make continuation inappropriate even if a model predicts successful repair?
3. What primary-source specification must be obtained before a technician can act?

WEEK 15 | Final engineering design review and oral defense

Lecture / theoretical framework

Complete a coherent design dossier including requirements, models, uncertainty, risk controls, component selections, budget, tests and a formal disposition. Demonstrate mastery by defending why competing architectures were rejected. Good engineering acknowledges unresolved hazards instead of concealing them.

The analytical objective is to justify the chosen system boundary and explain which variables were omitted. Develop an independent cross-check for the proposed interpretation, and distinguish an observed event from a confirmed causal mechanism. A single reading rarely justifies a hardware replacement; build an evidence hierarchy and show a test that could invalidate the initial diagnosis.

Synthetic case study

A mobile RV service unit must support refrigeration, lighting, communications and a constrained budget in varying temperatures.

Present competing hypotheses, severity-first hazards, and a source-backed diagnostic plan that does not exceed permitted supervision. Explain a plausible alternative that would result in a different repair decision.

Quantitative problem

A system demands 1.6 kWh/day over 3 days with combined storage-to-load efficiency 85%; estimate required initial stored energy.

Explain the derivation, units, order-of-magnitude reasonableness, assumptions and at least one sensitivity variation. Worked solutions are reserved for the faculty answer key.

Supervised laboratory

Present a safe low-energy subsystem prototype or validated simulation to a faculty review panel.

Required record: objective; protected/inert equipment configuration; data table and units; limitations; instructor sign-off; hazard and stop-work statement.

Ten-hour independent research assignment

Submit a 12-15 page engineering report, full calculation appendix and 12-minute oral defense.

Recommended distribution: four hours of source reading and technical verification, three hours of numerical/model work, and three hours of technical writing and revision.

Source evaluation

Appropriate design and safety standards; peer-reviewed technical literature; OEM manuals.

For research, use relevant manufacturer manuals and technical standards with current edition and jurisdiction verified. Disclose if the evidence is simulated or a generic estimate.

Seminar questions

1. What observation could disprove the current leading hypothesis?
2. Which risk would make continuation inappropriate even if a model predicts successful repair?
3. What primary-source specification must be obtained before a technician can act?

Technical source and approval register

The following references define external review boundaries; MRR does not claim authorship, RVTI endorsement or college approval.

GRCC Course Format & Credit Hour Policy (effective August 2025) —

https://www.grcc.edu/sites/default/files/docs/policy/7-13_Course_Format_and_Credit_Hour_2025-06_ada.pdf

GRCC Curriculum Development — <https://www.grcc.edu/faculty-staff/curriculum-support/curriculum-development>

RVTI Certification Levels — <https://www.rvti.org/career-path/training-levels>

RVTI Training Partners — <https://www.rvti.org/get-trained/find-training/training-partners>

Michigan Postsecondary Schools — <https://www.michigan.gov/leo/bureaus-agencies/wd/pss>