AUTOMOBILE ELECTRICAL AND ELECTRONICS

ENAM 426

Lecture	**: 3**	**Year : IV**
Tutorial	**: 2**	**Part : I**
Practical	**: 1**	

Course Objectives:

The objective of this course is to provide fundamental and advanced knowledge of electrical and electronic systems used in modern automobiles, including battery, starting, charging, ignition, sensors, actuators, ECUs and vehicle communication networks.

1 Automobile Electric Wiring and Battery (6 hours)

1.1 Electrical power and energy measuring instruments
1.2 Wiring harness and circuit layout
1.3 High-side driver and low-side driver circuits
1.4 Fuses, relays, switches
1.5 Battery construction and types
1.6 Rating, testing and charging/discharging of lead acid battery

2 Starting and Charging System (5 hours)

2.1 Starter motor construction, working and starting system
2.2 Alternator construction, working and charging system
2.3 Voltage regulator operation
2.4 Alternators characteristics

3 Ignition Systems (6 hours)

3.1 Conventional ignition
3.2 Electronic ignition
3.3 Different types of ignition systems
3.4 Spark timing and control
3.5 Spark plugs and its types

4 Lighting and Accessories (4 hours)

4.1 Automotive lighting systems Interior lightings and exterior lightings
4.2 Auxiliary body electronics systems: Horn, wiper, power window regulator
4.3 Central locking and security systems
4.4 Dashboard instrumentation

5 Sensors and Actuators (7 hours)

5.1 Sensor types and working principles

5.1.1 Air intake and load sensors (MAF, MAP)
5.1.2 Position sensors (TPS, CKP, CMP, EGR position)
5.1.3 Temperature sensors (ECT, IAT)
5.1.4 Exhaust and emission sensor (Oxygen, NOx, DPF differential pressure sensor)
5.1.5 Knock sensor
5.1.6 Vehicle speed sensor
5.1.7 Battery voltage sensor

5.2 Actuators and control signals
5.2.1 Fuel system actuator (Fuel pump, fuel injector)
5.2.2 Relay control
5.2.3 Air control actuator (IAC, ETC)
5.2.4 Emission control actuators (EGR valve)
5.2.5 EVAP Purge valve
5.2.6 Variable valve timing (VVT) actuator

6 Engine Management System (8 hours)

6.1 Engine management system (EMS)
6.2 Electronic control unit (ECU) architecture
6.3 Fuel injection system
6.4 Throttle body injection system
6.5 Multi-Port fuel injection system
6.6 Gasoline direct injection system
6.7 Common rail direct injection system
6.8 Close loop control systems

7 Communication and Advanced Systems (9 hours)

7.1 CAN protocol basics
7.2 On-board diagnostics (OBD) and trouble codes
7.3 ADAS working principle and architecture
7.4 Key sensors used in advanced driver assistance system (ADAS)
7.5 Major ADAS feature: Forward collision and lane departure warning and Automatic emergency braking
7.6 Driver assistance features: Hill start assist, adaptive cruise control and Lane keeping assist
7.7 Comfort features: Parking assist, 360-degree camera and driver fatigue detection
7.8 Society of automotive engineers (SAE) international levels of automation
7.9 Limitations of ADAS

Tutorial (30 hours)

1. Circuit analysis and failure mode evaluation of high-side and low-side drivers
2. Computational modeling of battery sizing, state of health (SoH) and charging efficiency

3. Performance analysis and numerical modeling of starter motors and alternators
4. Quantitative analysis of spark timing, dwell angle and combustion synchronization
5. Systematic interpretation and tracing of automotive wiring harnesses and circuit layouts
6. Technical evaluation and signal analysis of automotive sensors and final control elements
7. Architectural analysis and logic mapping of ECU and engine management systems (EMS)
8. Practical application and interpretation of CAN bus protocols and OBD-II trouble codes
9. Symptom-based fault tree analysis and systematic diagnostic methodology exercises

Practical **(15 hours)**

1. Characterization and performance testing of automotive batteries using multimeters and high-rate discharge testers
2. Bench testing and component-level study of starter motor engagement and cranking current draw
3. Evaluation and diagnostic testing of alternator output voltage and current regulation characteristics
4. Demonstration and signal verification of primary and secondary circuits in modern ignition systems
5. Systematic troubleshooting and isolation of body electrical fault.
6. Oscilloscope analysis and measurement of control unit inputs (Sensors) in MPFI and CRDI systems
7. Duty cycle and pulse-width measurement of control unit outputs (Actuators) in MPFI and CRDI systems
8. Implementation of on-board diagnostics (OBD) for fault identification and real-time data-stream analysis

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapters	Hours	Marks distribution*
1, 2	11	14
3, 4	10	14
5	7	10
6	8	10
7	9	12
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Bosch, R. (2022). Bosch automotive handbook. Robert Bosch GmbH.
2. Crouse, W. H., Anglin, D. L. (2017). Automotive mechanics. McGraw-Hill Education.
3. Denton, T. (2017). Automobile electrical and electronic systems. Routledge.
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5. Hollembeak, B. (2018). Automotive electricity and electronics. Cengage Learning.
6. Ribbens, W. B. (2017). Understanding automotive electronics: An engineering perspective. Butterworth-Heinemann.
7. Singh, K. (2017). Automobile engineering (Vol. 1 & 2). Standard Publishers Distributors.

QUALITY MANAGEMENT

ENME 430

Lecture	**: 3**	**Year : IV**
Tutorial	**: 2**	**Part : I**
Practical	**: 1**	

Course Objectives:

The objective of this course is to provide fundamental and advanced knowledge of quality management principles, tools, and techniques for improving product and process performance in mechanical engineering applications. It also aims to develop competency in applying modern quality approaches such as TQM, lean, and six sigma in industrial systems.

1 Introduction (3 hours)

- 1.1 Definition and dimensions of quality
- 1.2 Evolution of quality concepts
- 1.3 Contributions of Deming, Juran, Crosby
- 1.4 Quality in manufacturing and service industries
- 1.5 National and international quality standards (Including Nepal standards)

2 Total Quality Management (TQM) (5 hours)

- 2.1 Concept, principles and philosophy of TQM
- 2.2 Customer focus and continuous improvement (Kaizen)
- 2.3 Leadership, teamwork and employee involvement
- 2.4 Organizational culture and quality transformation
- 2.5 TQM implementation framework and barriers

3 Cost of Quality and Performance Measurement (4 hours)

- 3.1 Cost of quality (Prevention, Appraisal, Failure)
- 3.2 Economics of quality
- 3.3 Performance measurement and key indicators
- 3.4 Benchmarking techniques

4 Quality Systems and Standards (5 hours)

- 4.1 Quality management system (QMS)
- 4.2 ISO 9001 requirements and structure
- 4.3 Documentation and auditing practices
- 4.4 Certification and accreditation procedures
- 4.5 Integration with ISO 14001 and ISO 45001

5 Process Quality and Reliability (5 hours)

5.1 Process variation and control
5.2 Process capability indices
5.3 Reliability concepts and failure analysis
5.4 Maintainability and availability
5.5 Applications in mechanical systems

6 Inspection, Measurement and Metrology (4 hours)

6.1 Inspection planning and methods
6.2 Measurement systems and errors
6.3 Gauge capability and calibration
6.4 Basics of non-destructive testing (NDT)
6.5 Role of metrology in quality assurance

7 Statistical Quality Control (SQC) and SPC (8 hours)

7.1 Basic statistical concepts for quality
7.2 Control charts for variables and attributes
7.3 Process control and improvement
7.4 Process capability analysis
7.5 Acceptance sampling
7.6 Seven basic quality tools

8 Advanced Quality Improvement Techniques (5 hours)

8.1 Six sigma and DMAIC methodology
8.2 Lean manufacturing principles
8.3 Failure mode and effects analysis (FMEA)
8.4 Design of experiments (DOE) basics
8.5 Taguchi methods and loss function

9 Total Productive Maintenance and Quality in Manufacturing (6 hours)

9.1 Total productive maintenance (TPM) concepts and pillars
9.2 Overall equipment effectiveness (OEE)
9.3 Zero defect and zero breakdown philosophy
9.4 Safety systems and risk assessment
9.5 Industrial safety standards (ILO and national context)
9.6 Quality in machining and production systems
9.7 Automation and digital quality control
9.8 Smart manufacturing and real-time monitoring
9.9 AI and data analytics in quality management

Tutorial (30 hours)

1. Numerical problems on SPC and process capability
2. Case studies on TQM, lean and six sigma

3. ISO documentation and auditing exercises
4. Reliability and cost of quality analysis
5. Group discussions and presentations on quality management tools and techniques

Practical **(15 hours)**

1. Construction and analysis of control charts using software
2. Process capability study using sample data
3. Measurement system analysis (MSA)
4. Mini-project on quality improvement
5. Industrial visit and report

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapters	Hours	Marks distribution*
1, 2	8	11
3, 4	9	12
5, 6	9	12
7	8	11
8	5	7
9	6	7
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Montgomery, D. C. (2019). Introduction to statistical quality control. Wiley.
2. Evans, J. R., Lindsay, W. M. (2020). Managing for quality and performance excellence. Cengage Learning.
3. Besterfield, D. H. (2018). Quality control. Pearson.
4. Oakland, J. S. (2014). Total quality management and operational excellence. Routledge.
5. Pyzdek, T., Keller, P. (2018). The Six Sigma handbook. McGraw-Hill Education.
6. Juran, J. M., De Feo, J. A. (2017). Juran's quality handbook. McGraw-Hill Education.
7. Taguchi, G. (2005). Taguchi's quality engineering handbook. Wiley.

PRODUCTION PLANNING AND CONTROL

ENME 432

Lecture	**: 3**	**Year : IV**
Tutorial	**: 2**	**Part : I**
Practical	**: 1**	

Course Objectives:

The objective of this course is to develop advanced competency in Production Planning and Control (PPC) through the application of analytical models, optimization techniques, and modern digital tools. The course emphasizes systematic decision-making in complex manufacturing environments, focusing on efficient resource utilization, system integration, and real-time production monitoring and control.

1 Production Systems and PPC Framework (4 hours)

1.1 Strategic role of PPC in competitive manufacturing
1.2 Integration of PPC with supply chain and enterprise systems
1.3 Push and pull systems: Analytical comparison
1.4 Hierarchical production planning framework
1.5 PPC in flexible, agile and reconfigurable manufacturing systems
1.6 Case-based analysis of modern production systems

2 Advanced Forecasting and Demand Planning (5 hours)

2.1 Time-series decomposition (Additive and multiplicative models)
2.2 Advanced forecasting models: ARIMA (Conceptual), exponential smoothing variants
2.3 Causal forecasting and multivariate regression models
2.4 Forecast error analysis (MAD, MSE, MAPE) and bias tracking
2.5 Demand uncertainty and risk pooling
2.6 Collaborative forecasting and demand planning in supply chains

3 Aggregate Planning and Capacity Optimization (6 hours)

3.1 Mathematical models for aggregate planning
3.2 Linear programming formulation of aggregate plans
3.3 Transportation model applications
3.4 Capacity planning under constraints
3.5 Workforce planning with hiring/layoff costs
3.6 Multi-objective optimization (Cost versus service level)
3.7 Use of software tools for solving planning problems

4 Advanced Material Requirement Planning (MRP) (6 hours)

4.1 Material planning schedule stability, time fences and rolling schedules
4.2 Advanced MRP logic (Lot sizing rules: EOQ, LFL, POQ, Wagner-Whitin model)
4.3 Capacity requirements planning (CRP) with finite loading
4.4 Closed-loop MRP and manufacturing resource planning (MRP II)
4.5 ERP systems architecture and modules (SAP/Oracle overview)
4.6 Data integrity and system integration issues

5 Inventory Optimization Models (5 hours)

5.1 Deterministic and probabilistic inventory models
5.2 Multi-item inventory control and constraints
5.3 Stochastic inventory models (Service level approach)
5.4 Periodic review systems (P, Q systems)
5.5 Multi-echelon inventory systems (basic concepts)
5.6 Inventory optimization using simulation tools

6 Advanced Scheduling and Sequencing (6 hours)

6.1 Scheduling in complex systems (Flow shop, job shop, open shop)
6.2 Optimization objectives: Makespan, tardiness, flow time
6.3 Heuristic and metaheuristic approaches (Genetic algorithm concept, priority rules)
6.4 Johnson's rule and extensions
6.5 Finite versus infinite loading
6.6 Real-time scheduling and dynamic rescheduling
6.7 Applications in CNC and automated systems

7 Shop Floor Control and Real-Time PPC (4 hours)

7.1 Advanced dispatching and control strategies
7.2 Work-in-process (WIP) control and throughput analysis
7.3 Bottleneck analysis (Theory of constraints)
7.4 Drum-buffer-rope system
7.5 Real-time data acquisition (IoT in production systems)
7.6 Manufacturing execution systems (MES)

8 Lean, JIT and Agile Production Systems (5 hours)

8.1 Lean system design and value stream mapping (VSM)
8.2 Advanced Kanban systems and pull control
8.3 Just-in-Time in high variability environments
8.4 Agile manufacturing and mass customization
8.5 Hybrid systems (Lean and MRP integration)
8.6 Case studies (Automotive, electronics industries)

9 Integration of Maintenance, Quality and PPC (4 hours)

9.1 Maintenance planning in PPC (TPM integration)
9.2 Quality planning and control in production scheduling
9.3 Impact of reliability on production plans
9.4 Performance metrics: OEE, cycle time, throughput
9.5 Smart factories and cyber-physical systems
9.6 Digital twins in production planning
9.7 AI and machine learning in PPC
9.8 Big data analytics for production optimization
9.9 Future trends in production management

Tutorial (30 hours)

1. Numerical problems on:
   i. Aggregate planning using linear programming
   ii. MRP and lot-sizing techniques
   iii. Inventory models (Probabilistic and multi-item)
   iv. Scheduling optimization problems
2. Case studies on ERP, Lean and TOC
3. Software-based exercises (Excel solver, basic simulation)
4. Group discussions and presentations on industrial applications

Practical (15 hours)

1. Forecasting and demand analysis using spreadsheets/software
2. Aggregate planning using optimization tools
3. MRP simulation and ERP-based exercises (Demo-based)
4. Scheduling using Gantt charts and software tools
5. Simulation of production systems (Basic discrete-event models)
6. Mini-project: Design and analysis of PPC system for a manufacturing case

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapters	Hours	Marks distribution*
1, 7	8	11
2	5	7
3	6	8
4	6	8
5	5	7
6	6	8
8	5	7
9	4	4
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Vollmann, T. E., Berry, W. L., Whybark, D. C., Jacobs, F. R. (2017). Manufacturing planning and control for supply chain management. McGraw-Hill.
2. Silver, E. A., Pyke, D. F., Thomas, D. J. (2016). Inventory and production management in supply chains. CRC Press.
3. Nahmias, S., Olsen, T. L. (2015). Production and operations analysis. Waveland Press.
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5. Heizer, J., Render, B., Munson, C. (2020). Operations management. Pearson.
6. Krajewski, L. J., Malhotra, M. K., Ritzman, L. P. (2019). Operations management: Processes and supply chains. Pearson.
7. Pinedo, M. (2016). Scheduling: Theory, algorithms and systems. Springer.
8. Slack, N., Brandon-Jones, A., Johnston, R. (2019). Operations management. Pearson.