Indian Institute of Technology Indore

Course Structure
of
PG Program in
Center for Electric Vehicles and Intelligent Transport Systems (CEVITS)
and Syllabi of Courses

May 2026

[After incorporating decisions of the 63rd meeting of the Senate held on 19 May 2026]

Course Structure of M.Tech. and M.Tech. + Ph.D. dual degree program in Electric Vehicle Technology from AY 2021-22

{*Senate Resolution 34.4.1*}

Minimum Educational Qualification: Four-year Bachelor's degree or five-year integrated degree (with first division as defined by the awarding Institute/ University for Indian applicants and equivalent to International applicants, as assessed by the Institute) in Mechanical/Electrical/ Electronics and Communication/Automobile/Instrumentation and Control/Electronics/ Instrumentation//Production/Mechatronics Engineering. *Relaxation as per GoI norms in qualifying degree is applicable for SC and ST category applicants.*

Qualifying Examination:

(a) International students: Valid score of TOEFL or IELTS.

(b) Indian students: Valid GATE qualification in Mechanical (ME)/Electrical (EE)/Electronics and Communication (EC)/Production and Industrial (PI)/Instrumentation (IN) Engineering/Engineering Sciences (XE; Engineering Mathematics with Fluid mechanics/Material Science/Solid mechanics/Thermodynamics)

Categories of Admission:

(a) International Students: (i) International self-financed **(ISF)** students; (ii) International students sponsored by non-government organizations or by a reputed industry **(ISW)**; (iii) International students sponsored by foreign government or its organizations or through mutual collaborative programs of India with other countries **(GSW)**

(b) Indian Students: Teaching Assistantship **(Non-TA)**; (ii) Highly motivated sponsored candidate **(SW)** on full-time basis from highly reputed R and D organizations such as DRDO, ISRO, BHEL, C-DAC, ADE, ADA, etc. and highly reputed Industries; (iii) Defense Forces **(DF)**: Candidates sponsored by the Defense Forces; (iv) Regular institute staff **(IS)** of IIT Indore on part-time basis only.

Candidates of Non-TA, SW, DF and IS categories will not be provided any scholarship.

Duration of Program: 2 years on full-time basis.

Selection criteria: GATE Score and/ or Interview. (Valid GATE score compulsory for Non-TA category)

Total Intake: 5 TA, No upper limit on intake under non-TA category.

1st Year: Semester-I

Course Code	Course Title	Contact hours (L-T-P)	Credits
EV 608/ EV 408	Hybrid Electric Vehicles	2-1-0	3
EV 601/ EV 401	Vehicle Dynamics	2-1-0	3
EV 603	Autotronics	2-0-2	3
EV 605	Electric Machines and Drives	2-0-2	3
EV 607/ EV 407	Energy Storage in Electric Vehicle	2-1-0	3
Total minimum credits earned during the semester			**15**
Additional course (as per the requirement basis)			
HS 641	English Communication Skills	2-0-2	PP/NP

1st Year: Semester-II

Course Code	Course Title	Contact hours (L-T-P)	Credits
EV 602/ EV 402	Vehicular Communication System	2-1-0	3
ZZ XXX	Elective-I	2-1-0	3
ZZ XXX	Elective-II	X-X-X	3
ZZ XXX	Elective-III	X-X-X	3
ZZ XXX	Elective-IV	X-X-X	3
EV 698	PG seminar course	0-2-0	2
Total minimum credits earned during the semester			**17**

2nd Year: Semester-III

Course Code	Course Name	Contact hours (L-T-P)	Credits
EV 799	MTech Research Project (Stage-I)	0-0-36	18

Second Year: Semester-IV

Course Code	Course Name	Contact hours (L-T-P)	Credits
EV 800	MTech Research Project (Stage-II)	0-0-36	18
Total minimum credits to be earned during the program			**68**

Courses for Elective I to IV †			
Course Code	**Course Name**	**Contact hours (L-T-P)**	**Credits**
EV 609	Advanced Engine Technology	3-0-0	3
EV 610	Advanced Fuel Technology	2-1-0	3
EV 612/412	Data Science for Automotive Engineering	2-0-2	3
EV 614/ EV 414	Advanced Materials: Mechanics and Processing	2-1-0	3
EV 616/ EV 416	Fluid Power for Automotive Systems	2-1-0	3
EV 6XX	Fuel Cell Technology	2-1-2	3
MM 657*	Advances in Energy Storage Materials	2-1-0	3
MM 606*	Energy Materials	2-1-0	3
EV 6XX	Driver-Vehicle Interaction	2-1-2	3
ME 632/ 432*	Vibrations and Noise Control	2-1-0	3
ME 630*	Robotic Control Systems	2-1-2	4
ME672/ME472*	Reliability Engineering	2-0-2	3
ME 640/ ME 440*	Smart Materials and Structures	2-1-0	3
ME 644/ ME 444*	Robotics	2-0-2	3
ME 648/ ME 448*	MEMS and Micro-System Design	2-1-0	3
ME 756/ ME 456*	Industrial Automation	2-0-2	3
ME 643/ 443*	Micromechanics and Nanomechanics	2-1-0	3
ME 736 / ME 436*	Finite Element Methods	2-0-2	3
ME 637/ 437*	Fracture Mechanics	2-1-0	3
ME 671/ ME 471/ MA 671*	Operations Research	2-0-2	3
ME 618 / ME 418*	Computational Fluid Dynamics (CFD)	2-1-0 2-0-2 *(from AY 2021-22)*	3
EE601*	Power Electronics	2-1-0	3
EE603*	Optimization Techniques	2-1-0	3
EE638*	System on Programmable Chip Design	2-1-0	3
CS 601/ CS 401*	Soft Computing	2-0-2	3
CS 603/CS403*	Machine learning	2-0-2	3
CS619/CS419/ ICS419*	Computer Vision	2-1-0	3
CS620/CS420*	Embedded Systems	2-1-0	3
CS417/CS617*	Cryptography and Network Security	2-1-0	3

***Already approved course**

† In addition to this course list, a student can also opt from the PG courses being offered by the other disciplines.

NOTE:

1. Request for conversion from MTech to MTech + PhD dual degree will be considered after evaluating the research potential of the promising and motivating PG students at the end of the **third semester of their program.**

2. If the student opts for the Dual Degree Programme but cannot complete the requirements of a PhD, an **exit option** with the MTech Degree can be earned at the end of the final semester of the

normal MTech Programme by getting the MTech Research Project examined in the standard manner as per the requirements for the award of an MTech degree.

3. The enhancement in the scholarship from MTech to PhD will be from the beginning of the fifth semester or from the date on which all requirements for the award of MTech degree are fulfilled whichever is later**.**

Course Structure of Ph.D. Program in Electric Vehicle Technology by Center of Electric Vehicles and Intelligent Transportation Systems (CEVITS) (from AY 2023-24)
{*Senate Resolution 34.4.1*}

Minimum Educational Qualifications (MEQs): Masters' degree (with first division as defined by the awarding Institute/ University) in the relevant areas of Engineering/Sciences (Mechanical Engineering/Technology- Machine/system design/ Thermal Engineering/ Heat Power/Energy Materials/ Fluids & Thermal Engineering/ Manufacturing Engineering/ Industrial Engineering/ Production Engineering/ Reliability Engineering/ CAD/CAM/ Automobile Engineering; Metallurgical Engineering/ Material Science and Engineering/ Nanotechnology/ Nanotechnology/ Ceramics Engineering/ Chemical Engineering; Electrical/Electronics/ Electronics & Communication/ Instrumentation and Control Engineering/ Communications & signal processing/ VLSI/ Nanoelectronics/Image processing/ Speech processing/ RF-Microwave/ Power electronics/ Power systems / Control systems; Computer Science Engineering/ Information Technology/ Software Engineering/ Data Science/ Data Analytics; Transportation Engineering/ Aerospace Engineering/Space Engineering/ Aeronautics, Physics, Chemistry, Mathematics). *(Relaxation of 5% in CPI/ CGPA/ Percentage of the qualifying degree is applicable for Indian applicants belonging to SC, ST and PwD categories)*

Categories of Admission:
Indian students: FA (Fellowship Awardee), SW (Sponsored WITHOUT Institute scholarship), DF (Defense Forces), CT (College Teacher), IS (Institute Staff).
International students: ISF (International Self-Finance), ISW (International Sponsored by Industry or NGO), GSW (International Sponsored by Government organization)

Candidates will not be provided any scholarship for this program from IIT Indore.

Course Structure for Ph.D. Program in CEVITS

(A) Semester-I (autumn / spring)

S. no.	Course code	Course Title	L-T-P-Credits
1	ZZ xxx	Elective-I	x-x-x-3
2	ZZ xxx	Elective-II	x-x-x-3
3	ZZ xxx	Elective-III	x-x-x-3
4	EV 797* / EV 798*	Ph.D. Seminar Course	0-2-0-2

(B) Semester-II (autumn / spring)

S. no.	Course code	Course Title	L-T-P-Credits
1	ZZ xxx	Elective-I	x-x-x-3
2	ZZ xxx	Elective-II	x-x-x-3
3	ZZ xxx	Elective-III	x-x-x-3
4	EV 797* / EV 798*	Ph.D. Seminar Course	0-2-0-2

Note:

1. A Ph.D. student having M.Tech./ME/MPhil qualification has to complete at least two courses with a total minimum credit of 6. In addition, one Ph.D. seminar course needs to be completed by the applicant.
2. A Ph.D. student having M.Sc. or equivalent qualification has to complete 6 to 8 Ph.D. level courses of at least 3 credits each and 1-2 Ph.D. seminar courses of at least 2 credits each. The minimum number of courses will be 6 Ph.D. level courses and one Ph.D. seminar course (minimum coursework of 20 credits).

* Ph.D. Seminar course can be taken either in Autumn or in Spring Semester or both as suggested by the Faculty Advisor/Thesis Supervisor.

Courses for the Electives-I to VI: A student can opt from the PG courses being offered by any School/ Department/ Centre of IIT Indore as suggested by thesis supervisor.

Course code	**EV 601/ EV 401**
Title of the course	**Vehicle Dynamics**
Credit Structure	L-T-P–Credits 2-1-0-3
Name of the Concerned Department	Mechanical Engineering
Pre-requisite, if any	NA
Scope of the course	This course is designed for students from diverse engineering fields of study. This course shall cover fundamental approaches for vehicle dynamics modelling as well as study of important dynamic systems of the automotive systems including vehicle handling performance.
Course Syllabus	**Mechanisms, kinematics and balancing:** Introduction. **Introduction to vehicle dynamics:** History of motor vehicle age; Fundamental approach for modelling: lumped mass, vehicle and earth fixed coordinate systems; and Dynamic axle loads. **Acceleration and braking analysis:** Characteristics of conventional vehicle engines; Power train and different elements in it; Automatic transmissions; Selection of gear ratios; and Traction-limited acceleration. Basic equations; Braking forces; Tire-road friction; Requirement for braking performance; Brake proportioning; Anti-lock brake systems; Braking efficiency; Rear wheel lock-up; and Pedal force analysis. **Road loads and ride:** Aerodynamics: Mechanics of air flow and pressure distribution on vehicle, aerodynamic forces and aids, and different forces and moments; Rolling resistance; and Total road loads. Excitation sources; Vehicle response; and Perception of ride. **Steady state cornering:** Low-speed turning; High-speed cornering; Suspension effects on cornering; and Measurement of understeer gradient. **Suspensions:** Solid axles; Independent suspensions; Anti-squat and anti-pitch suspension geometries; Anti-drive suspension geometry; Roll center analysis; and Active analysis. **Steering systems:** Axis systems; Steering linkages; Steering geometry error; Front wheel geometry; Steering system forces and moments; Steering models; Effect of front-wheel drive; and Four-wheel steer. **Rollover:** Quasi-static rollover of rigid and suspended vehicles; Transient rollover; and Rollover accidents. **Tires:** Tire construction; Size and load rating; Terminology and axis system; Forces and moments acting on tire; Free rolling tire; Rolling resistance; Tire under braking, driving and cornering conditions; Combined cornering and braking/driving; Physical tire models; Camber thrust; Aligning moment; Conicity and ply steer; Durability forces; and Tire transient behavior and vibrations. **Vehicle handling performance:** Criteria for good handling; Single-track vehicle modeling; Steady and non-steady state analysis; and Graphical assessment methods.

Suggested Books	1. J.J. Uicker, G.R. Pennock, and J.E. Shigley, **Theory of Machines and Mechanisms**, Oxford University Press, New York, 2014, ISBN 978-0199454167 2. D.H. Myszka, **Machines and Mechanisms: Applied Kinematic Analysis**, Pearson, 2011, ISBN 978-0132157803 3. T.D. Gillespie, **Fundamentals of Vehicle Dynamics**, SAE International, 1992, ISBN 978-1560911999 4. J.P. Pauwelussen, **Essentials of Vehicle Dynamics**, Butterworth-Heinemann, 2014, ISBN 978-0081000366 5. R. N. Jazar, **Vehicle Dynamics: Theory and Application**, Springer, Boston, 2008, ISBN 978-0-387-74243-4

Course code	**EV 602/ EV 402**
Title of the course	**Vehicular Communication Systems**
Credit Structure	L-T-P–Credits 2-1-0-3
Name of the Concerned School/ Department/ Centre	Center for Electric Vehicles and Intelligent Transport Systems
Pre-requisite, if any	Basic knowledge of signal processing.
Scope of the course	This course will provide fundamentals of vehicular communications, networks, and advanced network security techniques specific to vehicular networks.
Course Syllabus	**Vehicular Communications:** Basics of Communication Systems in the context of vehicular communications, Vehicle-to-Everything (V2X), Vehicle-to-Infrastructure (V2I), Infrastructure-to-Vehicle (I2V), Vehicle-to-Vehicle (V2V), Infrastructure-to-Infrastructure (I2I) communications and architectures, Intelligent transportation systems, Standards for wireless access in vehicular environments (IEEE 802.11p), Vehicular Channel characterization and basic modelling. **Vehicular Networks:** Manually driving vehicular networks, Automated driving vehicular networks, Routing protocols. **Communication Security in EV Charging Systems:** EV Charging Security Requirements and Security Risks, Communication Security: Confidentiality and Message Integrity in Local Controllers, Non Repudiation, Firmware Integrity and Access Control in Local Controller and Authentication Terminal, Authentication Mechanisms, and Signature Schemes in Vehicular Networks, Cryptographic Communication protocols in EV Systems, Variants of security events and logging of security events in local controllers and authentication terminals.
Suggested Books	1. C. Sommer and F. Dressler, ***Vehicular Networking***, Cambridge University Press, 2014, ISBN: 9781107046719 2. X. Cheng, R. Zhang, and L. Yang, ***5G Enabled Vehicular Communications and Networking***, Springer publication, 2019, ISBN: 9783030021764 3. D. Stinson, ***Cryptography: Theory and Practice***, Chapman and Hall, CRC, 2006, ISBN: 9781138197015

Course Code	**EV 603**
Title of the course	**Autotronics**
Credit Structure	L-T-P–Credits 2-0-2-3
Name of the Concerned Department	Mechanical Engineering
Pre-requisite, if any	NA
Scope of the course	The innovations in vehicle architectures and systems that enable cutting edge success in the electric hybrid automotive which are of high demand in the recent years. Knowledge on automotive electronics in steering the mechanical component of automobile system is the key focus of this autotronics course. This course highly focus towards providing an exposure to the student community about the automotive instrumentation. Automotive electronic system concentrating on improving the engine controls, transmission drivetrains, actuators, automotive sensors , governing control systems, MEMS based devices for energy efficient systems and IOT enabled automotive diagnostic systems are some of the key topics focussed in this course.
Course Syllabus	**Automotive Instrumentation** The system approach to control and Instrumentation, electronic fundamentals, I/O signal flows and conversions, Multiplexing, fuel quantity measurement, coolant temperature measurement, oil pressure measurement, vehicle speed measurement, display devices and intelligent glass cockpit, Engine management system, ABS, Computer controlled dampers Automotive actuators and Transmission systems Actuator operations, Actuator for fuel injectors, gas circulation, idle speed control, ABS actuators, electronic unit injectors, Piezo electric energy harvesters, Transmission mechatronics system for electric hybrid vehicle 4 Wheel and 2 Wheel drives, Steer by wire and intelligent braking. **Automotive Sensors and MEMS systems** Electromagnetic sensors, optical sensors, combustion knock sensors, variable resistance type sensors, tyre pressure sensing, temperature sensors, ride height control sensors, manifold absolute pressure sensor, exhaust gas oxygen sensor, air low sensors, accelerometers and other sensors for steering by wire. **Vehicle control systems** Air fuel control, spark timing control, transmission control, clutch for awd, hybrid vehicles control, series parallel split hybrid and feedback based supervisory control, cruise control, ABS control and control for fuel systems **Automotive system Diagnostics** Circuit testing, six step approach, fault finding and emission related systems, ignition systems, sensor system and intermittent fault diagnostic systems, Intelligent collaborative diagnostic systems, IOT enabled conation monitoring and diagnostic systems
Suggested Books	1. W. B. Ribbens, 2017, ***Understanding Automotive electronics***, Butterworth–Heinemann ISBN -07506-7008-8. 2. A. Bonnick, 2001, ***Automotive computer controlled systems***, Butterworth–Heinemann ISBN -07506-50893.

	3. Uwe. K, L. Nielsen, 2005, ***Automotive control system***, Springer, ISBN-354023139-0 4. W. Bolton, 2019, ***Mechatronics, Electronics, Control systems in Mechanical Engineering***, Pearson Education ltd, ISBN 013121633 5. T. Denton, 2016, Routleg publisher, ***Advanced Automotive Fault Diagnosis: Automotive Technology: Vehicle Maintenance and Repair***, ISBN 978-0415725767

Course code	**EV 605**
Title of the course	**Electric Machines and Drives**
Credit Structure	L-T-P–Credits 2-0-2-3
Name of the Concerned Department	Electrical Engineering
Pre-requisite, if any	NA
Scope of the course	Motor drives are the core technology for EVs that convert the on-board electrical energy to the desired mechanical motion. Meanwhile, electric machines are the key element of motor drive technology. The requirements of electric machines for EVs are much more demanding than that for industrial applications. This course aims to cover all the fundamental aspects of electric machines and drive technology required for EVs.
Course Syllabus	Overview of Motor Drives Technology required for EVs **DC Motor Drives**: DC Machine modeling, DC Motor Control, Design Criteria of DC Motor Drives for EV **Induction Motor Drives:** Induction Machine modeling, Induction Motor Control like v/f control, vector control and DTC, Design Criteria of Induction Motor Drives for EVs **Permanent Magnet (PM) Brushless Motor Drives:** PM Brushless machines, PM Brushless Machine Control, Design Criteria of PM Brushless Motor Drives for EVs. **Switched Reluctance Motor (SRM) Drives:** Switched Reluctance Machines and related converters, Switched Reluctance Motor control, Design Criteria of SRM Drives for EVs. **Application examples for each motor drives related to EVs.** **Lab Component**: In practical sessions, experiments (accompanied with simulations) will give an idea about each motor drives performance and hands on experience on control design of these drives. Following experiments are proposed: 1) Control of a separately excited dc motor (1 Session) 2) V/F control of Three Phase Induction Motor (1 Session) 3) Study of Vector Control of Three Phase Induction Motor (Simulation + Experimental Verification) (2 Sessions) 4) Study of Direct Torque Control of Induction Motor (2 Sessions) (Simulation + Experimental Verification) 5) Study of Permanent Magnet Synchronous Machine (2 Sessions) (Simulation + Experimental Verification) 6) Study of Synchronous Reluctance Machine (2 Sessions) (Simulation + Experimental Verification)
Suggested Books	1. G. K. Dubey, "***Fundamentals of Electrical Drives***", CRC Press, 2002, New Delhi, ISBN 9780849324222. 2. De Doncker, Rik W., Pulle, Duco W.J., Veltman, Andre, "***Advanced Electrical Drives, Analysis, Modelling, Control***", Second Edition, 2020, Springer, ISBN 978-3-030-48977-9 3. K. T. Chau, "***Electric Vehicle Machines and Drives: Design, Analysis and Application***", John Wiley & Sons, Singapore Pt. Ltd. 2015, ISBN:9781118752524 4. John G. Hayes, G. Abas Goodarzi, "***Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and***

	Fuel Cell Vehicles", John Wiley & Sons Ltd, 2018, ISBN:9781119063643.

Course Code	**EV 607/ EV 407**
Title of the Course	**Energy Storage in Electric Vehicle**
Credit Structure	L-T-P-Credits 2-1-0-3
Name of the Concerned Discipline	Metallurgy Engineering and Materials Science
Pre–requisite, if any	None
Scope of the Course	This course is designed for the students of science and engineering disciplines to understand the use of energy storage materials in electrical vehicles. The basics of energy storage performance and cutting edge research developments will be covered from various books, research reports, articles and review papers.
Course Syllabus	**Battery Technology**: Introduction to common battery terminologies, Overview of the development of battery technology, Electrochemical energy storage mechanism in LIBs, Intercalation, conversion, and alloys type electrodes, Factors limiting the energy; power densities and cyclability of LIBs, Cell form factors (cylindrical, prismatic, and pouch), Capacity fading and battery failure mechanisms, Case study of commercially available LIBs, Emerging trends and beyond Li-ion battery technologies for EVs. **Battery Management System:** Introduction to BMS, charging discharging process, BMS requirements, Battery state of charge and state of health estimation, thermal management of battery. **Supercapacitor Technology**: Introduction to supercapacitor, Types and energy storage mechanism of SCs, Advances in supercapacitor, EDLC for transportation applications, Analysis and evaluation of EDLC, Thermal analysis and ageing in EDLC, Battery-Supercapacitor hybridization for large vehicles, Case studies, Emerging trends in supercapacitor. **Fuel Cell Technology**: Introduction to Fuel Cell, Types of Fuel Cell, Fuel cell thermo-chemistry and materials
Suggested Books	1. Edson R. Leite, **Nanostructured Materials for Electrochemical Energy Production and Storage**, Springer, 2009, ISBN 978-0-387-49323-7 4. Rui Xiong, Weixiang Shen, **Advanced Battery Management Technologies for Electric Vehicles**, Wiley, 2019, ISBN 9781119481645 5. B. E. Conway, **Electrochemical Supercapacitors Scientific Fundamentals and Technological Applications**, Springer, 1999, ISBN 978-1-4757-3058-6 6. Devid Linden and Thomas B. Reddy, **Handbook of Batteries, 3rd Edition**, McGraw-Hill, 2002, ISBN 9780071359788 7. C. G. Granqvist**, Handbook of Inorganic Electrochromic Materials**, Elservier, 1995, eBook ISBN: 9780080532905

Course code	**EV 608/ EV 408**
Title of the course	Hybrid Electric Vehicles
Credit Structure	L-T-P-Credits 2-1-0-3
Name of the Concerned Discipline	Mechanical Engineering
Pre-requisite, if any	Basic knowledge of Mechanical and Electrical Engineering
Scope of the course	This course is designed for final year undergraduate students and masters students who want to develop their knowledge about hybrid electric vehicles. Conventional I.C. Engine and electric powered vehicle will be analysed along with requirement of hybrid vehicle. Various mechanical layouts of hybrid powertrains will be examined to understand how they influence the performance and complexity of the powertrain. Sizing of the powertrains, Energy Management system and controls in the hybrid powertrain modes will be examined.
Course Syllabus	History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance. Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, and Switch Reluctance Motor drives. Energy Storage: Energy Storage Requirements in Hybrid and Electric Vehicles with Battery, Fuel Cell, Super Capacitor, and Flywheel based energy storage, Hybridization of different energy storage devices. Matching the electric machine and the internal combustion engine. Energy Management Strategies.
Suggested Books	1. I. Husain, ***Electric and Hybrid Vehicles*: Design Fundamentals,** CRC Press, Washington, 2011, 9781439811757 2. J. Larminie, J. Lowry, ***Electric Vehicle Technology Explained***, 2nd edition, John Wiley & Sons Ltd, U.K., 2012, 9788126557608 3. B. D. McNicol, D. A. J. Rand, ***Power Sources for Electric Vehicles,*** Elsevier publications, New York, 1988, 044442315X 4. S. Leitman, ***Build Your Own Electric Vehicle***, McGraw Hill, 1st Edition, WW, 2013, 978-0830642328

भारतीय प्रौद्योगिकी संस्थान इंदौर
Indian Institute of Technology Indore
IIT Indore
।। ज्ञानम् सर्वजनहिताय ।।

Course code	**EV 609**
Title of the course	Advanced Engine Technology
Course Category	Elective
Credit Structure	L - T - P – Credits 3-0-0-3
Name of the Concerned Department	CEVITS
Pre-requisite, if any	None
Scope of the course (Objectives)	The objectives of this course are to discuss the: • Limitations of conventional I.C. Engines • Advanced concepts of combustion in engines • Requirements of various engine sub-systems
Course Outcomes	At the end of this course the students will have the: • Engineering knowledge of advanced I.C Engines, spray and air-fuel fixture formation systems and the advanced combustion concepts • Ability to analyze IC Engine systems and propose design solutions for their development.
Course Content	• Introduction to I.C. Engine: Review of Ideal and actual cycles, Engine as a system and its different variants, Combustion and performance estimation • Intake System: Manifold requirement, Port design, Valve timing, Manifold flow dynamics and design, supercharging • Mixture Formation: Atomization, Fuel injection system, air-fuel mixture formation • Engine Combustion: Diesel and Gasoline combustion, Low temperature combustion, Basic considerations of Combustion Chamber design • Exhaust system: Design of exhaust manifold • Engine cooling and Lubrication systems : Heat balance, Requirement of cooling systems and types, Lubrication systems requirements and design • Engine emission and measurement systems

Suggested Books	Text Books: 1. J. B. Heywood, **Internal Combustion Engine Fundamentals**, McGraw-Hill Education Publications 2018 ISBN: 978-1260116106. 2. Heinz Heisler, **Advanced Engine Technology**, Society of Automotive Engineers,U.S.; New edition, 1995. ISBN: 978-0340568224. Reference Books: 3. R. Stone **Introduction to Internal Combustion Engines** Red Globe Press London, 1999, ISBN 978-1349149162 4. W. Pulkrabek **Engineering Fundamentals of the Internal Combustion Engine**, Pearson Publication 2003, ISBN 978-0131405707

Course code	**EV 610**
Title of the course	Advanced Fuel Technology
Course Category	Elective
Credit Structure	L - T - P – Credits 3-0-0-3
Name of the Concerned Department	CEVITS
Pre-requisite, if any	None
Scope of the course (Objectives)	The objective of this course is to discuss the choices of sustainable transportation fuels for I.C. Engine and the associated challenges
Course Outcomes	At the end of this course, the students will be able to: • Consider the various renewable fuels for use in engine and evaluate them on sustainability considerations.
Course Content	• Future direction for sustainable transportation, renewable and non-renewable fuels • Introduction to sustainability with reference to I.C. Engine fuels and the associated challenges in implementing the fuel choices • Ultra low emission combustion in IC. Engine • Alternative fuels : LNG, CNG, Ethanol, Methanol, Ammonia, Hydrogen, Biodiesel, Biogas : their Production, Characterization, Impact on engine combustion, performance and emissions,
Suggested Books	Text Books: 1. R. Bechtold **Alternative Fuels** SAE International ISBN 978-0768009071 2. J. B. Heywood, **Internal Combustion Engine Fundamentals**, McGraw-Hill Education Publications 2018 ISBN: 978-1260116106. Reference Books: 1. B.P. Pundir **Engine Emissions: Pollutant Formation and Advances in Control Technology** Alpha Science International Limited, 2007, ISBN 9781842654019

Course Code	**EV 612/ EV 412**
Title of the Course	**Data Science for Automotive Engineering**
Course Category	Core
Credit Structure	L-T-P-Credits 2-0-2-3
Name of the Concerned Discipline	Centre for Electric Vehicle and Intelligent Transport Systems (CEVITS)
Pre requisite, if any	None
Objectives of the course	• To integrate traditional mechanical concepts (like fatigue and thermal stress) with modern Data Science and Industry 4.0 frameworks. • To teach the end-to-end processing of automotive-specific data, from raw sensor ingestion like Controller Area Network (CAN) bus/ (Light Detection and Ranging) LiDAR to advanced feature engineering. • To equip students with the skills to build predictive maintenance models, computer vision architectures for autonomy, and high-speed surrogate simulations.
Outcomes	• Process and visualize complex automotive signals (CAN bus, LiDAR, Time-series) for stress, fatigue, and thermal modelling. • Develop machine learning pipelines for Remaining Useful Life (RUL) estimation, fault diagnosis, and anomaly detection. • Design computer vision and sensor fusion systems for real-time object detection and vehicle optimization.
Course Content	**Module 1: Introduction & Automotive Data Foundations** • Context: Industry 4.0, Software-Defined Vehicles (SDVs), and Digital Twins. • Data Sources: CAN bus, Electronic Control Unit (ECU) logs, Telematics, and LiDAR/Radar sensors. • Processing: Noise filtering, time-series resampling, and mechanical feature engineering. **Module 2: Exploratory Data Analysis & Visualization** • Methods: Z-scores (outliers), Correlation (sensor relationships), Weibull (reliability), and Principal Component Analysis (PCA) (dimensionality reduction). • Thermal/Stress: Heat transfer modelling and Rain flow counting for fatigue. • Visualization: Engine maps using Heatmaps, Waterfall plots using Noise, Vibration, and Harshness (NVH), and Global Positioning System (GPS) Trajectory traces. **Module 3: Machine Learning for Predictive Maintenance** • Regression: Linear, Polynomial, and Gaussian Process Regression (GPR) for predicting RUL of battery/brake life. • Classification: Random Forest, Support Vector Machine (SVM), and Convolutional Neural Networks (CNNs) for engine misfire and transmission diagnostics.

	• Anomaly Detection: Isolation Forest and SPC for real-time "out-of-spec" field test monitoring. **Module 4: Computer Vision & Autonomous Systems** • Image Basics: Filtering, Edge Detection (Canny), and Colour Space like Hue, Saturation and Value (HSV) for lane tracking. • Object Detection: You Only Look Once (YOLO) and Region-based Convolutional Neural Networks (R-CNN) for pedestrians and traffic signs. • Sensor Fusion: Combining Camera + Radar for Emergency Braking logic. **Module 5: Optimization & Future Trends** • Surrogate Modelling: Using Machine Learning (ML) to replace slow Computational Fluid Dynamics (CFD)/ Finite Element Analysis (FEA) simulations for aero and crash tests. • Production: Demand forecasting and CNN-based defect detection in Paint/Stamping shops. • Electric Vehicle (EV) Specialization: State-of-Charge (SoC) and Thermal runaway prediction. **List of representative experiments:** • Extract and decode raw vehicle sensor data from log files of CAN DBC. • Apply rolling average and low-pass filters to remove synthetic noise. • Resample and synchronize time-series data from multiple ECUs. • Calculate Z-scores on engine temperature data to identify outliers and potential overheating events. • Fit a Weibull distribution to historical transmission data to model component reliability and probability of failure. • Perform Rainflow counting on suspension stress logs to identify fatigue cycles and estimate cumulative structural damage • Generate a Brake Specific Fuel Consumption (BSFC) heatmap • Use PCA to visualize correlations across multiple sensor streams. • Train GPR and Polynomial Regression models to predict the RL) • Build a Random Forest and SVM classifier to categorize engine states • Convert dashcam frames to HSV colour space and apply Gaussian blur and Canny Edge Detection to track lane markings. • Deploy a pre-trained YOLO model to detect and draw bounding boxes around pedestrians, vehicles, and traffic signs in real-time video
Suggested Books	**Textbooks:** 1. G. N. Sastry, H. J. Mahanta, A. Kumar, S. Agmani, *Artificial Intelligence and Industry 5.0*, 1st Eds, 2025, PHI Learning Pvt. Ltd, ISBN: 9789354437427 2. H. Glanz and B. Davis, *Data Science for All*, 1st Eds, 2025, Pearson, ISBN: 9780138316242

	3. C. M. Bishop, *Pattern Recognition and Machine Learning,* 1 Eds, 2009, Springer, ISBN: 9781493938438 **Reference Books:** 4. C. Correa, J. Simon, M. Gubow, S. Bhagwat, *Automotive Ethernet: The Definitive Guide,* 2nd Eds, 2023, Intrepid Control Systems, ISBN: 9780578274003 5. A. Haleem and M. Javaid, *Digital Twin and Industry 4.0: Concepts, Frameworks, and Applications,* 1st Eds, 2026, Elsevier, ISBN: 9780443540196 *6.* P. Pathrose, *Software Defined Vehicles R-595:Automated and Autonomous Systems Connectivity and Software,* 1st Eds, 2025, SAE International, ISBN: 9781468609790

Course code	**EV 614/ EV 414**
Title of the course	**Advanced Materials: Mechanics and Processing**
Course Category	Elective
Credit Structure	L - T - P – Credits 2 – 1 – 0 – 3
Name of the Concerned Department	Centre for Electric Vehicle and Intelligent Transport Systems (CEVITS)
Pre-requisite, if any	None
Objectives of the course	• To develop a fundamental understanding of the mechanical behavior of materials relevant to heavy-duty equipment. • To analyze the influence of manufacturing processes, particularly welding, on microstructure, mechanical properties, and structural integrity. • To enable effective materials selection and design for components by considering performance, durability, cost, and service conditions.
Course Outcomes	• Analyze the elastic and plastic behavior of materials under static and dynamic loading conditions relevant to heavy machinery • Evaluate failure mechanisms such as fracture, fatigue, and wear in components under service conditions. • Assess the effects of welding and manufacturing processes on microstructure, properties, and structural integrity. • Select and design appropriate materials for engineering applications by considering performance, durability, and cost constraints.
Course Content	**Module 1: Basics of Deformation and Theories of Failure** Elasticity, stress vs. strain behavior, and thermal stresses; stress analysis using Mohr's circle and principal stresses under multi-axial loading; beam theory including shear force–bending moment relations and stress distribution in bending and shear. **Module 2: Fundamentals of Fracture and Fatigue** Introduction to fatigue failure, mechanisms, S-N curves, and mean stress effects; low/high cycle fatigue, crack growth, and Paris law; fatigue mitigation and modeling; fundamentals of fracture mechanics, fracture theories, stress intensity, energy release rate, fracture toughness, and advanced concepts like J-integral, R-curve, and CTOD. **Module 3: Introduction to Engineering Polymers, Composites, and Metallic Alloys** Composite materials: classifications, processing, and lamina/laminate analysis (macro- and micro-mechanics), including anisotropic behavior, strength, and failure criteria. Polymer materials: HDPE, LDPE, PEXL; thermal and UV stability, viscoelastic properties (DMA), glass transition

	(DSC), and coatings/primers for performance and durability. Metallic alloys: Steels, Al alloys **Module 4: Materials Selection and Design** Introduction to materials selection considering performance, constraints, and cost; use of Ashby charts and performance indices; integration with design and processing; failure considerations; and case studies on Engineering failure **Module 5: Material Processing and Characterization** Introduction to Mechanical working processes: Rolling, Forging, Extrusion, Sheet metal forming, etc.; Welding of steels, heat-affected zone (HAZ) and its properties, defects, and quality assurance using non-destructive testing (NDT) methods;
Suggested Books	**Textbooks** 1. G. E. Dieter, Mechanical Metallurgy, 3rd edition, McGraw-Hill Education (1986), ISBN-13: 978-0070168930. 2. L. S. Srinath, Advanced Mechanics of Solids, 3rd edition, Tata McGraw-Hill Education (2010), ISBN-13: 978-0070702530. 3. Sindo Kou, Welding Metallurgy, 2nd edition, John Wiley & Sons (2003), ISBN-13: 978-0471434917. 4. William D. Callister Jr. and David G. Rethwisch, Materials Science and Engineering: An Introduction, 9th edition, John Wiley & Sons (2014), ISBN-13: 978-1118324578. 5. Michael F. Ashby, *Materials Selection in Mechanical Design*, 5th edition, Butterworth-Heinemann (2016), ISBN-13: 978-0081006108 **Reference books** 6. Thomas H. Courtney, *Mechanical Behavior of Materials*, 2nd edition, McGraw-Hill (2000), ISBN-13: 978-0070131569. 7. Marc A. Meyers and Krishan K. Chawla, Mechanical Behavior of Materials, 2nd edition, Cambridge University Press (2008), ISBN-13: 978-0521866750. 8. ASM International (Editors: Brett A. Miller, Roch J. Shipley, Ronald J. Parrington, Daniel P. Dennies), *ASM Handbook, Volume 11: Failure Analysis and Prevention*, ASM International (2021), ISBN-13: 978-1627082938

Course code	**EV 616/ EV 416**
Course Title	**Fluid Power for Automotive Systems**
Course Category	Elective
Credit Structure	L-T-P-Credits 2-1-0-3
Department	Centre for Electric Vehicle and Intelligent Transport Systems (CEVITS)
Pre–requisite, if any	None
Objectives	To develop a strong foundation in hydraulic and pneumatic principles, fluid flow behaviour, and their role in automotive manufacturing systems.
Course Outcome	• To analyse, select, and design fluid power components and control systems, including electro-hydraulic and PLC-based automation. • To apply fluid power technologies in automotive automation and ensure efficient, safe operation through maintenance and troubleshooting
Course Content	**Module 1: Fundamentals of Fluid Power in Automotive Systems** Introduction to Fluid Power, Definition and role in industrial automation, Hydraulic vs Pneumatic systems, Advantages in automotive production, fundamentals of Fluid flow, Pressure, flow rate, power transmission, Pascal's law in hydraulic systems, Energy efficiency in fluid systems. Automotive Manufacturing and applications. Fluid power symbology and ISO standards (ISO 1219), Basic hydraulic circuit representation, Prime movers in hydraulic systems (electric motors, diesel engines). Hydraulic power transmission principles and systems. **Module 2: Fluid Power Components for Automotive Automation** Hydraulic System Components Pumps (gear, vane, piston), Hydraulic cylinders and motors, Reservoirs and accumulators. Pneumatic System Components Compressors, Pneumatic cylinders, Air preparation units (FRL) Control Valves, Directional control valves, Pressure relief valves, Flow control valves. Sensors and Auxiliary Devices Pressure sensors, Proximity sensors, Limit switches. Hydraulic fluids and their properties, Hydraulic filtration systems (suction, pressure, return filters), Hydraulic reservoirs and contamination control, Hydraulic cooling systems. Pressure reducing valves, counterbalance valves, pilot-operated valves, proportional directional control valves. Hydraulic accessories (filters, coolers, breathers). **Module 3: Electro-Hydraulic and Electro-Pneumatic Control** Systems Hydraulic and Pneumatic Circuit Design Basic circuit design principles, Speed control circuits, Pressure control circuits. Meter-in and meter-out flow control methods, independent metering control systems, load sensing hydraulic systems. Electro-Hydraulic Systems Solenoid operated valves, Servo and proportional control. Servo Valves and PLC's

	Electro-hydraulic feedback control, sensor-based control in automated hydraulic circuits, digital control in fluid power systems. **Module 4: Automotive Automation Applications and Maintenance** Fluid Power in Automotive Production Systems Hydraulic press machines Hydrostatic transmission systems in industrial machinery, hydraulic power steering and priority valve systems, mobile hydraulic applications in automotive equipment. System Maintenance and Troubleshooting Leak detection, Pressure loss analysis, Preventive maintenance. Contamination control in hydraulic systems, filter maintenance, diagnosis of hydraulic valve and pump failures, energy loss analysis in hydraulic circuits. Safety and Industry Standards Safety in hydraulic systems, ISO and automotive manufacturing standards, Energy efficiency and sustainability.
Suggested Books	**Text books:** 1. Anthony Esposito, *Fluid Power with Applications*, Pearson Education, 7th Edition, 2013, ISBN: 978-0135136902. 2. S.R. Majumdar, *Oil Hydraulic Systems: Principles and Maintenance*, McGraw Hill Education, 2001, ISBN: 978-0074637236 3. Herbert E. Merritt, *Hydraulic Control Systems*, John Wiley & Sons, 1967, ISBN: 978-0471596172. 4. John S. Cundiff, *Fluid Power Circuits and Controls: Fundamentals and Applications*, CRC Press, 2nd Edition, 2001, ISBN: 978-0849316038. **Reference Books:** 5. Bosch Rexroth, *Industrial Hydraulics Manual*, Bosch Rexroth AG, 6th Edition, 2011, ISBN: 978-0979969434. 6. Frank D. Petruzella, *Programmable Logic Controllers*, McGraw Hill Education, 5th Edition, 2016, ISBN: 978-0073373845 7. Andrew Parr, *Hydraulics and Pneumatics: A Technician's and Engineer's Guide*, Butterworth-Heinemann, 3rd Edition, 2011, ISBN: 978-0080966740.