

| RGPV (DIPLOMA WING) BHOPAL | | OBE CURRICULUM FOR THE COURSE | | FORMAT- 3 | Sheet No. 1/5 |
|-------------------------------|--|----------------------------------|-------------------|------------------|------------------|
| Branch | Electrical and Electronics Engineering | | Semester | 5 | |
| Course Code | 511 | Course Name | Electric Vehicles | | |
| Course Outcome 1 | Relate the necessity of electric vehicle in present scenario and compare various electric vehicles. | | | Teach Hrs | Marks |
| Learning Outcome E0151111 | Discuss the need of Electric Vehicles in present scenario. [Cognitive Domain] | | | 03 | 05 |
| Contents | <ul style="list-style-type: none"> ➤ Historical journey of hybrid and electric vehicle. ➤ Types of different pollutants produced due to IC engine vehicle (ICEV) and their effect on human health. ➤ Economic and environmental impacts of using Electrical vehicles. | | | | |
| Method of Assessment | External: End semester theory examination (Pen paper test) | | | | |
| Learning Outcome E0151112 | Classify Electric Vehicles based on various configurations. [Cognitive Domain] | | | 06 | 10 |
| Contents | <ul style="list-style-type: none"> ➤ Classification, Vehicle configuration and challenges of electric vehicles: <ul style="list-style-type: none"> • Pure Electric Vehicle (PEV) : Battery Electric vehicle • Hybrid Electric vehicle (HVE) • Conventional HVE: Micro, Mild and Full hybrid, series hybrid. Parallel hybrid, series parallel hybrid, complex hybrid. • Grid able HVE: plug in hybrid (PHEV), Range Extended (REV) • Fuel cell electric vehicle (FCEV) | | | | |
| Method of Assessment | Internal: Mid semester-I theory examination (Pen paper test) | | | | |
| Learning Outcome E0151113 | Identify components of Electric Vehicles used in various applications. [Cognitive Domain] | | | 04 | 08 |
| Contents | <ul style="list-style-type: none"> ➤ Components used in Hybrid Electric Vehicle. ➤ Solar electric vehicle: Solar electric power trains. ➤ Electric bicycle: Introduction, Electric bicycle propulsion system, Electric bicycle power distribution list. | | | | |
| Method of Assessment | External: End semester theory examination (Pen paper test) | | | | |
| Learning Outcome E0151114 | Compare various vehicles and identify its parts. [Affective & Psychomotor domain] | | | 06 | 10 |
| Contents | <ul style="list-style-type: none"> ➤ Develop block diagram of Electric vehicle and identify parts. ➤ Case study- Compare minimum three vehicles for economic and environmental analysis | | | | |
| Method of Assessment | Internal: Viva voce & report submission. | | | | |

| RGPV (DIPLOMA WING) BHOPAL | | OBE CURRICULUM FOR THE COURSE | | FORMAT-3 | Sheet No. 2/5 |
|-------------------------------|--|----------------------------------|-------------------|-----------|------------------|
| Branch | Electrical and Electronics Engineering | | Semester | 5 | |
| Course Code | 511 | Course Name | Electric Vehicles | | |
| Course Outcome 2 | Analyze various mechanical factors affecting movement of electric vehicle. | | | Teach Hrs | Marks |
| Learning Outcome E0151121 | Derive various equations for movement of vehicle. [Cognitive Domain] | | | 06 | 10 |
| Contents | <ul style="list-style-type: none"> ➤ General description of vehicle movement ➤ Rolling resistance and its equation ➤ Rolling resistance coefficient, factors affecting rolling resistance, typical values of rolling resistance. ➤ Aerodynamic drag and its equation, typical values of drag coefficient, Grading resistance | | | | |
| Method of Assessment | Internal: Quiz & Assignment. | | | | |
| Learning Outcome E0151122 | Compute different resistances affecting vehicle movement. [Cognitive Domain] | | | 04 | 07 |
| Contents | <ul style="list-style-type: none"> ➤ Grading resistance ➤ Road resistance, ➤ Acceleration resistance, ➤ total driving resistance ➤ Dynamic equation. ➤ Numerical | | | | |
| Method of Assessment | External: End semester theory examination (Pen paper test) | | | | |

| RGPV (DIPLOMA WING) BHOPAL | | OBE CURRICULUM FOR THE COURSE | | FORMAT-3 | Sheet No. 3/5 |
|-------------------------------|--|----------------------------------|-------------------|--------------|------------------|
| Branch | Electrical and Electronics Engineering | | Semester | 5 | |
| Course Code | 511 | Course Name | Electric Vehicles | | |
| Course Outcome 3 | Choose suitable motor for electric vehicle application. | | | Teach Hrs | Marks |
| Learning Outcome E0151131 | Explain constructional features & working of motors used in EV. [Cognitive Domain] | | | 06 | 10 |
| Contents | <ul style="list-style-type: none"> ➤ Difference between the electrical motors for electrical vehicles and for other industrial purpose. ➤ Classification of electrical motors used for EV applications: Induction Motor, Permanent magnet motor, switched reluctance motor. ➤ Construction working and control of permanent magnet motor. ➤ Construction working and control of switched reluctance motor. | | | | |
| Method of Assessment | External: End semester theory examination (Pen paper test) | | | | |
| Learning Outcome E0151132 | Select appropriate motor for EV application. [Cognitive Domain] | | | 06 | 10 |
| Contents | <ul style="list-style-type: none"> ➤ Factors to be considered for selection of motor. ➤ Regenerative breaking in motors. ➤ Configuration of motor layout: single motor configuration, dual motor configuration, in wheel motor configuration. | | | | |
| Method of Assessment | Internal: Mid semester-II theory examination (Pen paper test) | | | | |
| Learning Outcome E0151133 | Control the speed of motors used in electric vehicles. [Affective & Psychomotor domain] | | | 10 | 15 |
| Contents | <ul style="list-style-type: none"> ➤ To perform speed control experiment on BLDC. ➤ To perform speed control experiment on SRM. ➤ Visit to an Electric vehicle facility center to identify the type of motor configuration & prepare a report on it. | | | | |
| Method of Assessment | External: Report submission, Performance of given task and viva voce | | | | |

| RGPV (DIPLOMA WING) BHOPAL | | OBE CURRICULUM FOR THE COURSE | | FORMAT- 3 | Sheet No. 4/5 |
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| Branch | Electrical and Electronics Engineering | | Semester | 5 | |
| Course Code | 511 | Course Name | Electric Vehicles | | |
| Course Outcome 4 | Improve performance of electric vehicle by managing battery system. | | | Teach Hrs | Marks |
| Learning Outcome E0151141 | Compare different type of batteries used in EV. [Cognitive Domain] | | | 06 | 10 |
| Contents | <ul style="list-style-type: none"> ➤ Electrochemical Batteries: lead-acid battery, nickel based batteries, lithium-based batteries. ➤ Battery parameters: Physical Dimensions, Voltage and current rating ,Capacity and power 'C' Rate, Battery Efficiency, Energy Density, Power Density ,Sate of charge (SOC),Depth of discharge (DoD),State of Health (SoH), Operating Temperature ,Lifetime. ➤ Construction and working of lithium-based batteries. ➤ Comparison of batteries with respect to specific energy, specific power, cycle life, cost. ➤ Brief introduction of: Ultra capacitor, Ultra flywheel, Fuel cell. | | | | |
| Method of Assessment | External: End semester theory examination (Pen paper test) | | | | |
| Learning Outcome E0151142 | Manage battery system for EV. [Cognitive Domain] | | | 06 | 10 |
| Contents | <ul style="list-style-type: none"> ➤ Charging of EV and HEV <ul style="list-style-type: none"> • AC charging • DC Charging • Battery swapping • Smart charging • Wireless charging ➤ Battery Management System <ul style="list-style-type: none"> • Need of battery management system • Block diagram of BMS | | | | |
| Method of Assessment | External: End semester theory examination (Pen paper test) | | | | |
| Learning Outcome E0151143 | Maintain battery performance. [Affective & Psychomotor domain] | | | 09 | 15 |
| Contents | <ul style="list-style-type: none"> ➤ Measure normal open circuit voltage, charging voltage & current of a battery used in any vehicle. ➤ Verify Ampere-hour capacity of a battery with any load available. ➤ Visit to an Electric Vehicle charging station to identify the type of charging present there & prepare a report on it. | | | | |
| Method of Assessment | External: Report submission, Performance of given task and viva voce | | | | |

| RGPV (DIPLOMA WING) BHOPAL | | OBE CURRICULUM FOR THE COURSE | | FORMAT- 3 | Sheet No. 5/5 |
|-------------------------------|---|----------------------------------|-------------------|------------------|------------------|
| Branch | Electrical and Electronics Engineering | | Semester | 5 | |
| Course Code | 511 | Course Name | Electric Vehicles | | |
| Course Outcome 5 | Select suitable power electronic converter for EV. | | | Teach Hrs | Marks |
| Learning Outcome E0151151 | Explain power electronic circuits used in EV. [Cognitive Domain] | | | 06 | 10 |
| Contents | <ul style="list-style-type: none"> ➤ EV and EHV configuration based on power electronics. ➤ Converter requirement for on board charger. ➤ battery pack, motor drive, auxiliary battery ➤ Commonly used DC to DC converter in EV and HVE | | | | |
| Method of Assessment | External: End semester theory examination (Pen paper test) | | | | |
| Learning Outcome E0151152 | Differentiate various converters used in EV. [Cognitive Domain] | | | 06 | 10 |
| Contents | <ul style="list-style-type: none"> ➤ Isolated converter ➤ Non isolated converter ➤ Unidirectional and bidirectional converter ➤ DC to AC converter. | | | | |
| Method of Assessment | External: End semester theory examination (Pen paper test) | | | | |
| Learning Outcome E0151153 | Identify specifications of converters used in electric vehicles & prepare test report. [Affective & Psychomotor domain] | | | 06 | 10 |
| Contents | <ul style="list-style-type: none"> ➤ Prepare a report on specifications of converters used for Electric vehicles ➤ Prepare test procedure for equipment used in Electric vehicle. | | | | |
| Method of Assessment | Internal: Viva voce & report submission. | | | | |

Reference Books:

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3. Husain, I. *Electric and Hybrid Electric Vehicles*, CRC Press.
4. Chan C. C. and K. T. Chau, *Modern Electric Vehicle Technology*, Oxford Science Publication.
5. Gianfranco, *Electric and Hybrid Vehicles: Power Sources, Models, Sustainability, Infrastructure and The Market*, Pistoia Consultant, Rome, Italy.
6. Ehsani, M. *Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design*, CRC Press.
7. Lechner G. and H. Naunheimer, *Automotive Transmissions: Fundamentals, Selection, Design and Application*, Springer.
8. Rashid, M. H. *Power Electronics: Circuits, Devices and Applications*, 3rd edition, Pearson.
9. Moorthi, V. R. *Power Electronics: Devices, Circuits and Industrial Applications*, Oxford University Press.
10. Krishnan, R. *Electric motor drives: modelling, analysis, and control*, Prentice Hall.
11. Krause, O. P. ; C. Wasynczuk, S. D. Sudhoff, *Analysis of electric machinery*, IEEE Press.