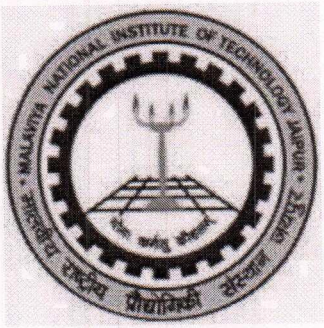
Electrical Engineering

Minor Specialization
In
Electric Vehicle

for B. Tech. (other than Electrical Engineering)

Course Structure
&
Syllabi



DEPARTMENT OF ELECTRICAL ENGINEERING

MALAVIYA NATIONAL INSTITUTE OF TECHNOLOGY JAIPUR

Curriculum Structure of B. Tech. (Minor in Electric Vehicle)

S. No.	Semester	Course Title	Credits (L T P)
1	V	Basic Power Electronics	3 (3 0 0)
2	V	Electrical Machines	3 (3 0 0)
3	VI	Electric Drives & Control	4 (3 1 0)
4	VI	Electrical Machines & Drives Lab	2 (0 0 4)
5	VII	Electric Vehicle Technology	3 (3 0 0)
6	VIII	Mini Project	3 (0 0 6)

SYLLABUS -B. TECH. (Minor in Electric Vehicle)

Semester: V
Course Title: Basic Power Electronics
Course Category: Program Core **Credit: 3 (3 0 0)**

Introduction: Concept, applications, and advantages of power electronics, power conversion necessity, ideal switch and its characteristics, types of power electronic conversions, key performance indices, power computations. Static and dynamic characteristics of practical switches i.e., SCR, TRIAC, power transistor, MOSFET, IGBT, Power diode, etc.

AC to DC Converters: Single-phase half-wave converters for a variety of loads (RL and RLE), single-phase full-wave uncontrolled, and fully controlled converters for a variety of loads (RL and RLE). Three-phase uncontrolled and fully controlled converters.

DC to DC Converters: Principle of choppers operation, quadrant operation of choppers, different schemes and circuit configurations: buck, boost, buck-boost and isolated converters.

DC to AC Inverters: Single-phase and three-phase inverter circuits operating as line-commutated voltage source inverters, force-commutated inverters. Basic idea of three-phase bridge inverter (RL load) and PWM based inverters.

Text / References Books:

1. Joseph Vithayathil, "Power Electronics: Principles and Applications", Tata McGraw-Hill Education, 2010.
2. Robert W. Erickson, Dragan Maksimović, "Fundamentals of Power Electronics", Springer, 2001.
3. Mohammad H. Rashid, "Power Electronics Circuits, Devices and Applications", Prentice Hall of India Pvt. Ltd, 2017.
4. Ned Mohan, Tore M. Undeland, William P. Robbins, "Power Electronics, Converters, Applications and Design", Wiley, 2017.
5. Hart, D.W., "Power Electronics". New York: McGraw-Hill, 2010.
6. Lander C. W., "Power Electronics", 3rd Ed., McGraw-Hill International Book Company, 2007
7. Sen, P. C, "Power Electronics", TMH, 1987.

Semester: V
Course Title: Electrical Machines
Course Category: Program Core **Credit: 3 (3 0 0)**

DC Motors: Basic principles of electromechanical energy conversion, construction, operation, armature reaction, commutation, characteristics, performance of dc motors, starting and speed control of dc motors, dc motors used in electric vehicles, applications of dc motors.

Induction Motors: Construction and working principle of cage and slip-ring induction motor, slip, equivalent circuit, torque-slip curves, performance, starting and speed control of three-phase induction motors.

Synchronous Motors: Working principle, starting, equivalent circuit model, phasor diagram, operation and applications of synchronous motors. Permanent magnet synchronous motors (PMSM), brushless DC motor (BLDC), switched reluctance motors (SRM).

Text / References Books:

1. Irving L. Kosow: Electric Machinery and Transformers, Prentice Hall India Publication.
2. A.E. Fitzgerald, Charles Kingsley: Electrical Machines, IV Edition, Mc-Graw Hill.
3. A.S. Langsdorf: Theory of Alternating Current Machinery, Tata Mc-Graw Hill.
4. I.J. Nagrath, D.P. Kothari: Electrical Machines, Tata McGraw Hill.
5. M. G. Say: The Performance and Design of Alternating Current Machines, III Edition, CBS Publishers & Distributers.

Semester: VI
Course Title: Electric Drives & Control
Course Category: Program Core **Credit: 4 (3 1 0)**

Introduction and Dynamics of Electric Drives: Concept of electric drives, advantages, parts of electric drives, speed torque conventions, multi-quadrant operation, types of loads and load torques, components of load torques, referred load torque/load inertia, determination of the moment of inertia, calculation of starting time, steady-state stability analysis, ratings of converters and motors, speed transitions curves.

Power Rating and Heating of Drive Motors: Load diagram, overload capacity, insulating materials, heating and cooling of motors, service conditions of electric drives (continuous, intermittent, short time), selection of motor power capacity, operation of drives under shock loading condition.

DC Motor Drives: Steady-state speed-torque relations, methods of speed control, starter design, regenerative braking, dynamic braking, plugging, single-phase and three-phase AC to DC converter-fed dc separately excited motor, controlled rectifier fed dc series motor, single/two/four quadrant chopper fed dc separately excited motor and dc series motor, converter rating, and closed-loop control.

AC Motor Drives: Steady-state characteristics, starting methods, braking, frequency-controlled induction motor (IM) drives, voltage source inverter fed IM, multi-quadrant operation, current source inverter (CSI) fed IM, ac voltage controller fed IM, closed-loop control of IM.

Text Books:

1. G. K. Dubey, "Fundamental of Electric Drives", 2nd Ed., Narosa Publishing House.
2. V. Subrahmanyam, "Electric Drives, Concepts and Applications", 2nd Ed, TMH, India, 2011.
3. S. K. Pillai, "A first course in electric drives", 2nd Ed., New Age International Private Ltd.
4. N. K. De and P. C. Sen, "Electric Drives", Printeice Hall, India, 2006.

Reference Books:

1. P. C. Sen, "Thyristor DC Drives", John Willey & Sons.
2. J. M. D. Murphy & F. G. Turnbull, "Power Electric Control of AC Motors", Pergamon Press.
3. B. K. Bose, "Power Electronics and Variable Frequency Drives", IEEE Press, Standard Publisher Distributors.
4. R. Krishnan, "Electric motor drives: modeling, analysis, and control", Prentice Hall PTR, 2001.

Semester: VI
Course Title: Electrical Machines and Drives Lab
Course Category: Program Core **Credit: 2 (0 0 4)**

Section A

List of Experiments:

CYCLE –I

1. To control the speed of a given dc shunt motor by armature control method and plot back emf v/s speed characteristics

2. To control the speed of a given dc shunt motor by field control method and plot field current v/s speed characteristics.

3. To perform the indirect load test on a given dc shunt motor and plot the output power versus
   (a) torque output(b) armature current (c) speed, and (d) efficiency

4. To make the stator winding connections of the given three-phase induction motor for (a) 4 pole and (b) 8 pole star configuration and measure the line and phase voltages and line current.

CYCLE – II

1. To control the speed of a given three-phase cage induction motor using stator voltage control.

2. To perform the indirect load test on a given three-phase induction motor and plot the following performance characteristics
   a) torque v/s output power
   b) torque v/s speed
   c) torque v/s efficiency
   d) output power v/s slip

3. To separate the constant losses from the stator core loss of the given three-phase induction motor.

4. To start the given synchronous motor using induction starting. Measure the slip while the machine is working as (a) induction motor (b) synchronous motor.

Section B

List of Experiments:

CYCLE 1

1. To study and experimentally validate the performance of AC voltage regulator using the following methods:
   (a) TRIAC;
   (b) Anti-parallel thyristors; and
   (c) Combination of TRIAC and DIAC.
2. To study and experimentally verify the performance of 'R', 'RC' and UJT triggering circuits for SCR firing.
3. To study VI characteristics of TRIAC
   (a) Forward VI characteristics of TRIAC with positive gate current.
   (b) Reverse VI characteristics of TRIAC with positive gate current.
4. To study and evaluate the performance of single-phase inverter (DC-AC).
5. To study and evaluate the performance of three-phase inverter (DC-AC).

CYCLE2

1. To test the four-quadrant operation of DC motor using chopper.
2. To perform speed control of separately excited DC motor drive by DC-DC chopper.
3. To study the speed control of a three-phase AC Induction Motor drive with spring balance load by V/f Control method.
4. To verify the operation of Boost Rectifier with Power Factor Correction (PFC).
5. To analyse the performance of Non-Isolated Switch Mode DC-DC Converter.

Semester: VII
Course Title: Electric Vehicle Technology
Course Category: Program Core **Credit: 3 (3 0 0)**

Overview of Electric Vehicles and Vehicle Mechanics: Modern electrical drives: Overview of electrical machines, power converters, embedded control and communication links, drive design methodology. Hybrid Electric Vehicles (HEV), engine ratings, comparisons of EV with internal combustion engine vehicles, fundamentals of vehicle mechanics.

Architecture of EV's and Power Train Components: Architecture of EV's and HEV's – Plug-in Hybrid Electric Vehicles (PHEV) - Power train components and sizing, gears, clutches, transmission and brakes.

Energy Storage and Management: Battery basics, different types, battery parameters, battery modeling, traction batteries. Fuel cell – characteristics- types – hydrogen storage systems and fuel cell EV – super capacitors, flywheels. Significance of battery management technology, development of battery management technologies, BMS key technologies.

Battery Chargers: EV and PHEV Battery Chargers: Forward/Fly back converters, half-bridge DC–DC converter, full-bridge DC–DC converter, power factor correction stage, bi-directional battery chargers, other charger topologies, inductive charging, wireless charging, V2G and G2V, bi-directional power flow.

Indian Government Policies: NITI Aayog involvement, FAME scheme and its phases, rate of deployment of EV off-board chargers, cost effective policies. Case studies of popular EVs on the road.

Text / References Books:

1. Seth Leitman and Bob Brant," Build Your Own Electric Vehicle", Mc Grew Hill, 2009.
2. Jiuchun Jiang and Caiping Zhang, "Fundamentals and Applications of Lithium-Ion Batteries in electric Drive Vehicles", Wiley, 2015.
3. Chris M., M. AbulMasrur and David Wenzhong Gao, "Hybrid Electric Vehicles Principles and Applications with Practical Perspectives", Wiley, 2011.
4. Iqbal Hussain, Electric and Hybrid Vehicles - Design Fundamentals, Second Edition, CRC Press, Taylor & Francis Group, Second Edition, 2011.
5. Ali Emadi, Mehrdad Ehsani, John M.Miller, Vehicular Electric Power Systems, Special Indian Edition, Marcel dekker, Inc, 2010.
6. Modern Electric Vehicle Technology by C. C. Chan, K. T. Chau, United Kingdom: Oxford University Press, 2001.