



**DoT**  
DEPARTMENT OF  
TECHNOLOGY

Ref. No.: Tech/243/2021

Date: 25/02/2021

**ADVERTISEMENT**

**Call for quotations for various Scientific Equipment and Apparatus and Software Solution.**

**Department of Technology, Savitribai Phule Pune university, Pune-07.**

**To whom it May Concern:**

Sealed quotations in plain envelope are invited from the intending registered firms, authorized Distributors/dealers holding valid PAN and GST number for supply, installation and maintenance Of items listed in table below.

Sr.No.	Name	Qty .
1	3D Automation Software-20Users	1
2	Virtual Factory Automation Software-20Users	1
3	Universal Pro Virtual Reality Software-20Users	1
4	Electrical DC Drive Simulation Software-20Users	1
5	Electrical AC Drive Simulation Software-20Users	1
6	Computer Aided E-learning solution for Electrical drives for E-Mobility Electrical Drive Learning -20Users-05 Year	1
7	3D Modelling electrical design Software-20Users	1
8	Electrical Drive design Software-20Users	1
9	Mechatronics Design Simulation Software-20Users	1
10	Digital Electronics Design Software-20Users	1
11	Data acquisition /control unit (PC Interface unit)	1
12	Electrical Motor Open Lab System	1
13	Electrical Drive System	1
14	LMS based E-learning for automotive essentials for E-Mobility	1

Interested Parties must send their quotations comprising of prices for each and 1- year support (as per annexure) on or before **04:00 PM, 04 March 2021** to Department of Technology, SPPU

The quotations received incomplete in any from or after scheduled date will be disqualified. The Undersigned reserves the right to reject any or all the quotations.



तंत्रज्ञान विभाग,  
सावित्रीबाई फुले पुणे विद्यापीठ  
गणेशखिंड, पुणे ४११००७, भारत

Department of Technology,  
Savitribai Phule Pune University  
Ganeshkhind, Pune - 411007, INDIA

Head

Department of Technology  
Head of the Department  
Department of Technology  
Savitribai Phule Pune University  
Pune 411 007

Annex-

## 1. 3D Automation Software-20Users

### Technical Specifications

Software platform should be support for following languages and plc platform for research and development puporse

#### 1.Programming languages:

Ladder, Logic, Flow chart, Literal, Function blocks, Grafcet/SFC, CEI 1131-3.

#### 2.Compatible PLCs or targets:

- SCHNEIDER (PB, SMC, TSX17-10, 17-20, 47, 07, 37, 57, ZELIO, ZELIO2, TWIDO, M340).
- SIEMENS (S5, S7).
- ABB (CS31, AC31), KLOCKNER-MOELLER (PS3, PS4, PS414).
- GE-FANUC (90 Micro, 9030), CEGELEC (C50, C100, 8005,8035).
- OMRON (C, CV, CS), MITSUBISHI (FX, Q).
- FESTO.
- PANASONIC.LEGO RCX, LANGUAGE C, PC (I/O drivers available for I/O driving - use a PC as a PLC), others.

## 2. Virtual Factory Automation Software-20Users

### Technical Specifications

- Powerful. Design and validate new production solutions confidently, with 3D manufacturing simulation software.
- Designed for manufacturing professionals and built on a powerful, flexible, and scalable platform.
- It should be capable to Layout Configuration, Process Modelling, CAD Compatibility, Project Ready Deliverables, Simple Robotics, Component Modeling, advanced Robotics, Interactive VR.
- It should be open and modular, making customization of the platform easy.
- It should be includes built on .NET, Python API familiar framework support for many developers.
- The core services layer was designed to allow for easy customization of everything, from the UI to simulation behaviours.
- It should be includes several rendering modes, helping you see more details and features and providing a richer and more immersive viewing experience.
- With advanced lighting and shading models and the ability to view material textures, models in the 3D world look realistic and pictures and videos exported from the platform are marketing-grade.
- The x-ray mode helps with identifying root causes and issues when you're designing new components, configuring layouts, and analyzing collisions.
- Defining and editing products and processes has been greatly simplified, requiring a fraction of the steps.
- Ready to use models:- Library contains 2000+ ready to use models and build the layouts quickly
- Components can be dragged into the 3D view and they connect to each other automatically.  
Example: A gripper can be automatically attached to the robot just by drag it closer to the robot
- Components communicate with each other through signals and interfaces. This configuration should be done with simple mouse clicks
- Connect to various PLC brands through OPC UA interface
- Through .NET and Python connect the simulated device directly to the physical device
- Import and Export of 2D drawing is possible from and to the software. You can import 2D DXF or DWG. You can also export the 2D drawing to PDF
- Import 25+ CAD formats including STEP, IGES, CATIA, Inventor etc.
- Present the simulation as 4K HD videos. Videos look realistic and good for presentations, marketing videos etc.
- Export the simulation data as Excel charts. Production Indicators, Cycle, Takt times etc.

- Export the simulation as VR animations that can be opened from PC, Mobile, VR glasses etc.
- Factory layouts, warehousing, storage, ASRS, AGV, Conveyors, Robotics, Process
- Built in .NET and Python API allows you to develop your own applications with help this virtual software.
- Built library design support should be required from bidder or service provider time to time whenever required.
- Built in library for post processor development support should be required for any one industrial 5-Axis robot.
- 6-axis, delta (spider configuration), cartesian configuration (XYZ), scara robots and you can also create your own robot configurations
- Robot tool can be jogged in many ways. This is useful because different configurations can be jogged better in specific ways.
- Robots can be programmed with in minutes though simple mouse clicks and snap features. Irrespective of which robot brand you use, programming is same. You do not need to re-learn what you have already learnt even if you change the robot brand
- Collisions can be checked by activating the collision pairs
- If the robot passes through the singularity point, we can make it stop working
- Robots never exceed the joint limits
- Robots never exceed the joint speeds, reliable cycle times
- Robot Configuration for a specific position can be changed through a drop-down list
- Using built-in wizards and templates you can create new and re-usable components
- Create the pick & place programs in various coordinate systems so as to avoid reprogramming if the picking & placing positions are moved
- You can create various zones in the vacuum grippers and can activate only specific areas with specific signals
- Create complex mechanical multiple gripper combinations with integrated mechanisms for Machine.
- Using Machine Tending Library, with in minutes you can create complex machine tending applications. It can be a fully automatic (with only robots), semi automatic (robots and manual operations), or fully manual simulations
- ASRS library helps to quickly build the ASRS layouts. You can build complex ASRS systems with lifts, special zones for special parts, RFID etc.
- We have many ready to use AGVs from various manufacturers. You can build complex warehouses with AGVs

- Using Packaging library, you can create complex packaging lines, with in minutes using wrappers, carton openers, destackers etc.
- Using Works Library, you can assign the tasks various tasks to the humans, machines and other resources and analyse various KPI
- Factory Design with Process Modelling Using Process Modelling features, you can create huge factories and get analytics such as:-through put, bottlenecks, cycle times, utilization charts etc.
- You can select the spot positions on the work piece and robot program is automatically generated or generate the welds automatically from CSV files
- Simulation of Pick, Place and Palletizing with robots
- Simulation of robotic sealing application
- Robotic cutting,, deburring paths generated through path command to create hundreds of points with a mouse click
- Simulation of robotic painting that gives the information about paint deposition, visual paint representation etc.
- Robot Modelling--Create robots of your own configuration and drive them with own algorithms
- Advanced Python Libraries:- Helps in prototyping own machines
- Advanced .NET Libraries:- Helps in connecting to various platforms such as web services, IoT devices etc
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- Robot Modelling--Create robots of your own configuration and drive them with own algorithms
- Advanced Python Libraries:- Helps in prototyping own machines
- Advanced .NET Libraries:- Helps in connecting to various platforms such as web services, IoT devices etc.

### 3. Universal Pro Virtual Reality Software-20Users

#### Technical Specifications

Virtual reality should be AR and VR technology development.

Creating powerful 3D simulations of automated systems has never been easier. Users will experience amazing immersive experiences enjoying the best high-quality rendering technology supporting virtual reality headsets.

Developing powerful simulations in the cloud places your users in a collaborative environment which enhances their experience beyond anything available before. Simulations can be accessed from a range of devices including smart-phones, tablets and laptops anywhere in the world.

Software should be coming with 60 defined objects for content development for ready to use for students for experiment developments example should be as follows:-

Colour boxes source, concave part A, concave part B, concave part C, HMI Tablet, HMI tablet support, Light column, Loading conveyor, Gaz tank (Layout), Grid, Handrail, Helper, Primitive Part-A, Primitive Part-B, Pusher, Rack, Pick and place, Pillar(Layout),Platform(Layout),Polymorphous art,Store,Tank,Turn Table,Vive controller #1,sorter,Source of boxes with overpadding,stairs( Layout),stopper, coloured boxes source, Concave part-A, Concave part-b, Convex part-A, Boxes Source,Chute,CNC,colour Sensor, Gaz Tank(Layout),Grid, Handrail,Helper,Elevator,Factory layout-1, Factory layout-2,fast sorter, pick and place-2,pillay layout-2,platform layout,Polymorphus Art,palette,Pallettes layout,Pallettes source,palletizer,Sorter-2,Source of Boxes with over packing, Stairs layout,Stopper,Sensor,Sensor,Sink,smart source, Boxes source,Chute,CNC,Colour sensor,Alarm,Arm,Array sensor,Box,Elevator,Factory Layout, Factory layout, fast sorter,Conveyer-4M, Conveyer-6M, Conveyer-8M, Conveyer-90 degree,Pallete,Palletes layout, pallet source,Palletizer,Normalizer, Normalizer,Overpack boxes source,Overpacking,Sensor,sensor,Sink,Smart source,Reflector,Reflector,Robot,Robotic Arm,Alarm,Arm,Array Sensor,Box,Vive controller #2,Vive headset, Weighing conveyor, Overpacking.

Drive the simulations with a real PLC\*, an automation workshop\*\* or a virtual controller included in Virtual Universe Pro.

Hardware support: -Siemens S7 IP, MPI, PPI, Siemens S5, Schneider Electric TSX, SoMachine, Twido, Beckhoff, Mitsubishi, Rockwell Ethernet IP, CodeSys PLCs compatibles, Automgen targets (Eg. Arduino), Modbus TCP, SLMP, OPC.

Software Driver support: -Siemens PlcSim, Schneider Unity, Schneider SoMachine, Mhj WinSps, CodeSys, Omron Cx-Simulator, Rockwell Soft Logix, Automgen (all compatible targets), Matlab Simulink, Labview, Proteus, all software or programming tools dll, ip, universal memory access.

About fifteen ready-to-use examples illustrate the use of the library objects.

For each object, an optimized interface composed of inputs, outputs and parameters makes it easy to control the object from an automation program.

The configuration of each object is accessible and editable, this allows you to redefine the



characteristics of the objects of the library and to understand how to create your own objects. You can also mix library objects with your own creations created from your usual CAD\* software.

Control panels are used to drive the objects manually and to observe the various associated states. They

have the dual purpose of being able to test the functioning of the objects before realizing the program that will

use them and also to simulate failures.

All the library objects are compatible with the use of a virtual reality headset. The controllers associated with the VR headset allow a full immersion and interaction.

#### Technical Specifications

- Development Operating System: -Windows XP, Windows Vista, Windows 7, Windows 8, Windows 10.
- PC Configuration: -Nvidia GTX 980 equivalent or higher Intel Core I5 or higher 4 Gb ram or higher.
- VR: -Oculus Rift headset, HTC Vive headset and controllers, Mixed reality headsets and controllers. All Steam VR compatible systems.
- AR: -Microsoft HoloLens, Android devices.
- Physic engines: -Newton Dynamics, NVidia Physix and Chrono Engine.
- Rendering: -Realtime, HQ, PBR, Unity 3d.
- Web Player: -WebGl IE, Chrome, Firefox, Safari.
- Collaborative cloud simulation: -Server on Windows, Web clients on PCs, Web clients on mobile devices, Web clients on Macs, Clients on Windows + VR Headsets.
- Integrated Simulation Tools: -Pneumatic, Hydraulic, Electric, Digital Electronic and Schematic Blocks (Simulink).
- Direct PLCs Connections: -Siemens S7 IP, MPI, PPI, Siemens S5, Schneider TSX, So Machine compatible PLCs,
- Unity compatibles PLCs, Twido, Beckhoff, Mitsubishi, Rockwell Ethernet IP, CodeSys PLCs compatible
- Automgen compatible target (Eg. Arduino),I/O connection with Advantech cards.
- PLC protocols: -Modbus TCP, SLMP, OPC.
- PLC simulators interface: -Siemens PlcSim, Schneider Unity, Schneider So Machine, Mhj WinSps, CodeSys.
- Omron Cx-Simulator, Rockwell Soft Logix, Mitsubishi Gx-Simulator.

- Software connections: -Automgen (all compatible targets), MATLAB Simulink, Labview, Proetus Robotstudio,
- Mitsubishi RT-Toolbox2, mBlock, all software's or programming tools dll, ip, universal memory access.
- Integrated programming tools: -Ladder, Grafcet, Function blocks, Script (Basic), C language.
- CAD Import Formats: -DS Solidworks, DS Catia, Autodesk Inventor, Siemens Solid Edge.
- Import from 3D files: -3DXML, OBJ, 3DS, FBX, X, VRML, STL, DXF, SKP.
- Licence: -standalone soft code or floating license or web license.

#### **4. Electrical DC Drive Simulation Software-20users**

##### Technical Specifications

The software guarantees a complete experience in the field of electrical machines. Students can approach this topic starting from the basic concepts, such as the analysis of magnetic fields and fluxes, up to advanced experiments based on characterization of machines and efficiency analysis.

Through this system, it is possible to assemble a relevant number of electric machines to carry out the following didactic experiences:

- Study of the magnetic field
- Principles of the electromagnetic induction
- Separately shunt, series and compound excited DC motors
- Separately shunt, series and compound excited DC generators
- Induction motors: three-phase slip ring and squirrel cage, single-phase repulsion and with capacitor
- Dahlander connection
- Synchronous three-phase motor, induction regulator and phase shifter, alternator, universal motor

##### SET OF ASSEMBLED MACHINES

The system is based on a set of components that allow the assembly of the rotating machines. The set consists

of the following components:

1. Base plate
2. Supports with bearing
3. Coupling joints
4. Flexible coupling
5. Electronic speed transducer
6. Assembling screws
7. Wrenches

8. DC stator
9. AC stator
10. Rotor with commutator
11. Brush holder with 2 brushes
12. Squirrel cage rotor
13. Slip-Ring rotor
14. Brush holder with 6 brushes

The system should be includes adjustable DC and AC power supplies, instruments, loads, starting devices, etc., in order to perform all the experiments of the electric machines.

#### LEARNING TOPICS

This software covers 6 topics and proposes 45 experiments for the students.

The experiments are listed below, grouped by learning topics.

#### GENERAL CHARACTERISTICS AND BASIC CONCEPTS

- 1 Flux produced by the poles
- 2 Main magnetic field
- 3 Intensity of the magnetic field
- 4 Induced voltage
- 5 Inter pole effect
- 6 No-load magnetic neutral axis
- 7 Rotating magnetic field

#### DIRECT CURRENT MOTORS

- 22 DC motor with separate excitation
- 23 DC motor with shunt excitation
- 24 DC motor with series excitation
- 25 DC motor with compound excitation, long shunt
- 26 DC motor with compound excitation, short shunt

## COMMUTATOR MOTORS FOR ALTERNATING CURRENT

27 Single phase series motor

28 Repulsion motor

## SYNCHRONOUS MACHINE

29 Synchronous motor winding resistance

30 Synchronous motor no-load test

31 Synchronous motor short-circuit characteristics

32 Synchronous motor short-circuit test

33 Synchronous motor Behn - Eschenberg's method

34 Synchronous motor load test

35 Synchronous motor conventional efficiency

36 Parallel connection of the alternator with the mains

37 Alternator as synchronous motor

## DIRECT CURRENT GENERATORS

38 DC generator winding resistance

39 DC generator test of the no-load motor (Swinburne)

40 DC generator no-load e.m.f.

41 DC generator excitation characteristics

42 Separate excitation dynamo

43 Shunt excitation dynamo

44 Series excitation dynamo

45 Compound excitation dynamo

Support for Software use and apply

1. Bidder server as a Service

The authentication and courses server may be delivered as a service, at Server. That means that the school does not need to have any local infrastructure. That is a good option when the internet network is good at the school.

## 2. USB DONGLE

In case the student or the school does not have suitable internet connections, De Lorenzo can provide licensing through USB DONGLES. In this case, if the student works from time to time in the school and home, he/she needs to keep the USB DONGLE and a USB FLASH MEMORY with him. The USB DONGLE is required to use the system and the USB FLASH MEMORY is required to save the student's progress and course information so that when the student has an internet access, he/she may upload the information.

### DESCRIPTION OF PERFORMABLE EXPERIMENTS

Here follows a short description of some of the performable experiments.

Three-phase squirrel cage motor, 2 poles, 24 V $\Delta$

This experiment studies the behavior of the three phase squirrel cage motor in load condition with the stator windings connected in delta.

Three-phase squirrel cage motor, 2 poles, 42 VY

The main objective of this experiment is to study the characteristic curve of a three-phase squirrel cage motor with the stator winding connected in star by performing a direct test using an electromagnetic brake.

Three-phase squirrel cage motor, 2 poles, 24 V $\Delta\Delta$

Applying the same concepts studied up to this point, the student can plot the load characteristics of the three-phase squirrel cage motor connected in double delta.

Three-phase squirrel cage motor, 2 poles, 42 VYY

Following the same procedure with the stator winding connected in double star, the student will trace the curves for the absorbed current  $I$ , the power factor  $\cos\phi$ , the speed  $n$  and the efficiency  $\eta$  as a function of the output power  $P$ .

Three-phase squirrel cage motor, 4 poles, 24 VΔ

In addition to recording the operation characteristics of the motor, the student will learn how to start the motor using a star-delta starter.

Three-phase squirrel cage motor, 4 poles, 42 VY

In this experiment, the student will learn the load operation of a three-phase motor with 4 poles.

Three-phase squirrel cage motor, 4/2 poles, 42V□/YY

In previous experiments, it has been demonstrated that by changing the number of poles it is possible to vary the speed of a squirrel cage motor. The student will learn about two-speed Dahlander motor configuration and its operation.

Split phase motor

The split phase motor, also known as a resistance start motor, has a single cage rotor and its stator has two windings known as main winding and starting winding. The main objective of this experiment is to study the characteristics of the motor with the main winding only, and to draw the curves of current I, efficiency  $\eta$ , torque C, output power P and power factor.

Capacitor start and run motor

The objective is to study the characteristics of the motor with permanently connected capacitor. The student will learn how to properly select and connect a capacitor to the auxiliary windings so that the current through the main winding lags behind the current of the auxiliary windings by an angle of 90°.

Three-phase motor with wound rotor, 2 poles, 42 VYY

The student will record the load characteristics of the motor with a wound rotor and the stator connected in double star. With the knowledge acquired up to this point, it will be easy to draw the diagram of the mechanical characteristic  $M = f(n)$  and to observe the behavior of an induction motor with a different type of rotor.

Phase shifter

The objective is to study how the phase between the stator and rotor voltages varies as a function of the rotating angle and to identify the null phase shift condition using Lissajous' ellipse by setting the oscilloscope to XY mode.

#### Induction regulator

The objective is to study the operation of a three phase voltage regulator. By using a locking and rotating module with a graduated disc, the rotor can be turned by means of the hand-wheel until the load current results null with minimum indication of the voltmeter.

The student will measure the absorbed current at constant load and draw the current and voltage curves as a function of the angular phase shift.

#### Three-phase synchronous induction motor, 2poles, 42V

This experiment studies how to start and synchronize the induction motor using the starting rheostat and studies the load characteristics of the motor at synchronous speed.

#### Three-phase synchronous induction motor, 2poles, 24V

Following the same procedure as in previous experiment, the diagram of the absorbed current  $I$ , the power factor  $\cos\phi$  and the efficiency as a function of the output torque  $C$  will be traced with the stator wired in delta-delta configuration.

#### DC motor with separate excitation

Now, it is time to work with DC motors. The first application refers to a separately excited DC motor, where the field winding is powered by an external independent source. The DC motor operation characteristics will be studied as a function of the excitation voltage.

#### DC motor with shunt excitation

By performing this experiment, the student will learn how to connect the armature and field windings in parallel and compare the behavior with the previous experiment.

#### DC motor with series excitation

Unlike in the DC shunt motor, the DC series motor has very poor speed regulation. The main objective of the experiment is to draw the characteristics of the output power  $P$ , the speed  $n$ , and the efficiency as a function of the absorbed current  $I$ .



#### DC motor with compound excitation, long shunt

By combining the operational characteristic of both the shunt and series excited DC motor, we obtain the DC compound excitation motor. The operation of the motor is studied with cumulative and differential excitation.

#### DC motor with compound excitation, short shunt

This experiment shows why the compound motor responds better to heavy load changes than a shunt motor.

#### Single-phase series motor

The single phase series motor, also known as a universal motor, is a rotating machine similar to a DC motor, but designed to operate either from DC or single-phase AC.

#### Repulsion motor

The repulsion motor combines a stator of a single phase motor with a rotor similar to that of a DC motor. The main benefit of the repulsion motor is that the armature is separated from the line. The main objective of this experiment is to record its operation characteristics.

#### Measure the windings resistance of the alternator

This experiment calculates the voltage drops across the rotor winding resistance of an induction motor using the Ohm's law. The winding resistance value of the alternator is useful to calculate the conventional efficiency.

#### No-load test of the alternator

The main objective of this experiment is to determine the mechanical and iron losses of the alternator and to record its magnetization characteristic using a DC motor as prime mover.

#### Short-circuit characteristic of the alternator

The short-circuit test of the synchronous generator provides information about its current capabilities. It is performed by driving the generator at its rated speed while the terminals of the armature winding are shorted.

This characteristic diagram is essential for the application of the indirect testing method of the alternator.

#### Load test of the alternator

This test compares the behavior of a synchronous generator connected to a variable external load with its no-load operation.

#### Conventional efficiency of the alternator

The conventional efficiency of a synchronous machine is determined by measuring the losses at different power factors, using the results from the previous experiments.

#### Parallel connection of the alternator with the mains

This experiment studies an operation which is frequently performed in a power station. The synchronization of a generator consists of electrically coupling the generator output to another source of electric energy and operating the generator such that its output adds to the other source.

#### “V” curve of the synchronous motor

The V-curve of a synchronous machine shows its performance in terms of variation of the armature current with the field current when the load and the input voltage of the machine are maintained constant.

The student will trace different V curves for particular resistant torque applied to the motor axis.

#### Measure the windings resistance of the DC generator

This experiment demonstrates how measuring the internal resistance of a DC machine can be used to establish the integrity of the machine windings and internal connections.

#### Test of the no-load motor (Swinburne)

In order to design rotating DC machines with higher efficiency, it is important to study the losses

occurring in them. Swinburne's method consists of operating a dynamo as a DC motor with no load to determine its mechanical and iron losses.

This is done by increasing the armature voltage  $U$  while measuring the armature current  $I_a$  and the excitation current  $I_e$ .

#### Magnetization characteristic of a DC Generator

This experiment studies the magnetization characteristic of a separately excited DC generator using a three-phase synchronous motor as prime mover.

#### Separate excitation dynamo

The main objective of this experiment is to record the external and regulation characteristics of a separate excitation generator to determine its conventional efficiency.

This is done by measuring the output voltage  $U$  as a function of the load current, with constant excitation current  $I_e$ .

#### Shunt excitation dynamo

The previous experiment is replicated with a different configuration of the DC generator. Using the results from the previous experiments, the student will plot the external and regulation characteristic of the generator connected in shunt.

#### Series excitation dynamo

Determining the external characteristic of a DC generator connected in series is to observe how the voltage slightly drops as the load increases. The student will use these results to calculate the conventional efficiency of the dynamo.

#### Compound excitation dynamo

This experiment follows the same procedure as the previous ones with the generator in compound excitation connection. After performing this last experiment, the student will be able to make comparative analyses between all the different DC generator configurations.

## 5. Electrical AC Drive Simulation Software-20Users

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- Induction motors: three-phase slip ring and squirrel cage, single-phase repulsion and with capacitor,
- Dahlander connection
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of the following components:

1. Base plate
2. Supports with bearing
3. Coupling joints
4. Flexible coupling
5. Electronic speed transducer
6. Assembling screws
7. Wrenches
8. DC stator
9. AC stator
10. Rotor with commutator

11. Brush holder with 2 brushes
12. Squirrel cage rotor
13. Slip-Ring rotor
14. Brush holder with 6 brushes

The system should be includes adjustable DC and AC power supplies, instruments, loads, starting devices, etc., in order to perform all the experiments of the electric machines.

#### LEARNING TOPICS

This software covers 6 topics and proposes 45 experiments for the students.

The experiments are listed below, grouped by learning topics.

#### GENERAL CHARACTERISTICS AND BASIC CONCEPTS

- 1 Flux produced by the poles
- 2 Main magnetic field
- 3 Intensity of the magnetic field
- 4 Induced voltage
- 5 Inter pole effect
- 6 No-load magnetic neutral axis
- 7 Rotating magnetic field

#### INDUCTION MOTOR

- 8 3-phase squirrel cage motor, 2 poles, 24V $\Delta$
- 9 3-phase squirrel cage motor, 2 poles, 42 VY
- 10 3-phase squirrel cage motor, 2 poles, 24V $\Delta\Delta$
- 11 3-phase squirrel cage motor, 2 poles, 42VYY
- 12 3-phase squirrel cage motor, 4 poles, 24V $\Delta$
- 13 3-phase squirrel cage motor, 4 poles, 42 VY
- 14 3-phase Dahlander motor, 4/2 poles, 42V $\Delta$ /YY
- 15 Split phase motor

16 Capacitor start and run motor

17 3-phase motor with wound rotor, 2 poles, 42 VYY

18 Phase shifter

19 Induction regulator

20 3-phase synchronous induction motor, 2poles, 24 VΔ

21 3-phase synchronous induction motor, 2poles, 24 VΔΔ

## 6. 3D Modelling electrical design Software-20Users

### Technical Specifications

The Simulation software module should be a software that has been developed to teach main topics related to electric machines in a unique and effective way. With this software, students can improve their individual experience studying electric machines in practice. Students will be able to carry out several experiments dealing with the following topics:

- mechanical assembly,
- wiring, tests and measurements.

This software should be having built in capabilities to reproduce the features and behaviours of Open lab Electric Machines.

Software should be useful for students to learn in their own rhythm and teachers have more time to support the class, manage and improve the process because - unlike any other simple simulator - it grants the following benefits:

**EFFECTIVE GUIDE FOR STUDENT:** possibility to access learning topics, with theory, instructions and experiment proposals. The software includes a virtual version of the DL OPENLAB system;

**AUTOMATIC VALIDATION OF STUDENTS' TASKS:** the software automatically verifies if the student completed successfully each task in order to allow him/her to go ahead with the next one;

**TRACKING OF STUDENTS' PROGRESS:** the teacher can verify the students' progress any time consulting the specific summary in the software or exporting it to a spreadsheet.

With this software, the teacher spends less time explaining topics, verifying students' activities and helping students do identify mistakes that do not allow the successful completion of the experiment. That means that the professor has more time to manage the class, make improvements and help students who need more attention. The two following points grant such benefits:

The software automatically verifies the experiments carried out by the students and it gives relevant feedbacks:

Like in a game that has different phases with challenges and missions, the DL OPENLAB-SSEM software includes practical experiments that need to be successfully completed to let the student access the next one. The teacher does not need to verify continuously if the student carried out the experiment. Moreover, many questions students would make about "what could be wrong" are automatically "answered" by the software when the student does not perform the experiment successfully. The image below summarizes this process.

The software tracks the students' progress and it allow exporting reports:

At any time, the professor may verify how many and – specifically - which experiments the student

has completed. That report can be used to track students' activities and it can be considered as an evaluation tool. This report can be generated and displayed directly in the system or it can be exported to a spreadsheet.

#### Timestamp Student Topic Experiment

Smart Design simulations and design software should be useful for design develop and apply design concept got electrical power drives. The features of the same software should be as follows:-

#### DIGITAL CONTROL IMPLEMENTATION

Users can design control directly in the z-domain with a full suite of discrete elements. C code can be automatically

generated from the schematic for seamless implementation on a supported TI C2000/6000 DSP. The automatic embedded code generation capability provides a true Rapid Control Prototyping workflow with either floating point or IQmath fixed point code.

#### MULTI-LEVEL SWITCH MODELS

Using one switch model to simulate control, gate drive, switching & conduction losses, conducted EMI, etc. is not practical when simulation time and complexity is considered. It provides a selection of switch models for optimal simulation performance: Ideal, Level 1, Level 2, Thermal, and SPICE.

#### SOLAR AND WIND POWER SYSTEMS

Photovoltaic, wind turbine, and battery models with varying complexity are provided for renewable energy and microgrid

simulations. Sample MPPT and complete wind power system examples are available. With no limit on switch numbers or topology, systems of any size and complexity can be simulated efficiently.

#### MAGNETICS DESIGN

Magnetic circuits with air gaps, leakage, and saturable cores can be defined. Additionally, inductor losses can be simulated with a database of manufacturer core materials and shapes. Winding configuration, wire type (round, square, litz), and proximity to core allow the model to provide winding and core losses that include proximity and skin effect impacts.

#### WIDE BAND GAP DEVICES (SiC & GaN)

Evaluating the benefits of SiC/GaN and comparing with traditional devices is straightforward with multi-level switch models.

Thermal loss models specifically for WBG operating characteristics are available along with novel WBG SPICE models which feature more robust simulation performance than standard behavioural models.

#### CODE VERIFICATION

A built-in C compiler allows code to execute with a simulated power stage. IQmath data type can be



assigned to check for fixed-point overflow. A processor-in-the-loop simulation can test how your code actually executes on the MCU, critical for time sensitive or fixed point implementations. FPGA users can

validate Verilog/VHDL code with ModelSim co-simulation.

It should be a powerful software for designing, exploring and comparing power converter designs, multidisciplinary integration, Power tool empowers development teams with a unique tool for designing lighter, smaller and more efficient converters in record time. 01Nos. 16,46,879.00

- Induction motors: three-phase slip ring and squirrel cage, single-phase repulsion and with capacitor
- Dahlander connection
- Synchronous three-phase motor, induction regulator and phase shifter, alternator, universal motor

#### SET OF ASSEMBLED MACHINES

The system is based on a set of components that allow the assembly of the rotating machines. The set consists

of the following components:

1. Base plate
2. Supports with bearing
3. Coupling joints
4. Flexible coupling
5. Electronic speed transducer
6. Assembling screws
7. Wrenches
8. DC stator
9. AC stator
10. Rotor with commutator
11. Brush holder with 2 brushes

12. Squirrel cage rotor

13. Slip-Ring rotor

14. Brush holder with 6 brushes

The system should be includes adjustable DC and AC power supplies, instruments, loads, starting devices, etc., in order to perform all the experiments of the electric machines.

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9 3-phase squirrel cage motor, 2 poles, 42 VY

10 3-phase squirrel cage motor, 2 poles, 24V $\Delta\Delta$

11 3-phase squirrel cage motor, 2 poles, 42VYY

12 3-phase squirrel cage motor, 4 poles, 24V $\Delta$

13 3-phase squirrel cage motor, 4 poles, 42 VY

14 3-phase Dahlander motor, 4/2 poles, 42V $\Delta$ /YY

15 Split phase motor

16 Capacitor start and run motor

17 3-phase motor with wound rotor, 2 poles, 42 VYY

18 Phase shifter

19 Induction regulator

20 3-phase synchronous induction motor, 2 poles, 24 VΔ

21 3-phase synchronous induction motor, 2 poles, 24 VΔΔ

## 7. Electrical Drive design Software-20Users

Technical Specifications

, It should offer a seamless experience from product specification stages to trade-off of most complex multilevel topologies and sizing of passive and active components.

Bidirectional conversion stages from kW to MW

- Non-isolated DC/DC
- 3-phase DC/AC
- RLE model for AC load (motor, grid,)
- Automated design generation: 2-level and multilevel
- 3-level Neutral-Point Clamped (3L-NPC)
- 3-level T-type (3L-T-type)
- Stacked Multicell (multilevel SMC)
- Parallel interleaved Flying Capacitor (multilevel FC)

Libraries of public references

- Discrete and modules of IGBTs & MOSFETs
- Magnetic powder alloys & ferrites
- Plastic film capacitors
- Thermal interfaces
- Private references in library
- Private discrete and module (leg, T-type, NPC) library
- references, providing loss data in PLECS XML format

- Private semiconductor package footprints

Ready-to-use file exports for industry-standard software

- simulation & PLECS export (simulation models and semiconductor loss data)
- FEMM 2D magnetics models
- Web-based access
- Installation-free, maintenance-free
- Collaborative software with individualized access rights
- Third-party software interface

SPICE

- Support for SPICE models and SPICE simulation
- Motor Drive
- Adjustable speed drives & motion control
- Digital Control
- Digital control systems in z-domain
- SimCoupler
- Co-simulation with Matlab/Simulink®
- Thermal
- Quick power loss calculation
- Renewable Energy
- Solar/wind power & energy storage systems
- HEV Design Suite
- Hybrid electric vehicle powertrain system design
- Motor Control Design Suite
- Motor drive system controller design SimCoder
- Automatic code generation from schematic to C code

Hardware Targets

- Auto code generation for TI's F2833x, F2837x, F2803x,

- F2802x, F2806x series DSP, and Myway PE-Expert4 hardwarePIL
- Processor-In-the-Loop simulation with TI DSP
- MagCoupler & MagCoupler-RT
- Co-simulation with JMAG® and link to JMAG-RT files for finite element analysis
- ModCoupler-VHDL & ModCoupler-Verilog
- Co-simulation with ModelSim® for VHDL & Verilog support Book Exercise
- Interactive, electronic textbook to master circuit simulations

#### SUPPORT/TRAINING RESOURCES

We provide expert technical support from power electronic engineers with a direct line of contact to a committed support team. A fast-learning curve means easy implementation and seamless adoption. Through email, online, or phone support, access-built in resources on your terms and when you need it.

#### VIDEOS

Getting started to advanced topics, on demand. 50+ videos available.

#### APPLICATION EXAMPLES

Hundreds of models & pre-built schematic files.

#### LIVE WEBINARS

Interactive & catered to current interests.

## 8. Mechatronics Design Simulation Software-20users

### Technical Specifications

Latest virtual automation tool should be a single platform comes with three different platform points Scada with RUN time and Development platform, Virtual PLC simulation Software Platform and Virtual 3D simulation for electronics, Hydraulic and Pneumatic.

The Software platform should be useful to simulated following parameter step by step,

- Realistic 3D process simulation with physical engine,
- Electric, pneumatic, hydraulic and digital electronic simulation.

This platform should be comes with different following platform which are useful for research and development.

### Virtual PLC Simulation Platform

Simulation systems provide effective support with the development of programs and the following actual application. In the automation environment, a simulated test environment including PLC and process reduces startup times and thus costs, for example.

Early discovery of programming errors and optimization of program sections enable the optimized and error free use of the programs in the actual system. If a program is modified, it can be tested prior to loading it onto the plant control system.

It should be comes with simulation tool for Siemens controller families for smaller simulation task with the new develop controller also.

it should be must more complex simulations with the new controllers.eg. Employing virtual controllers.

It should be useful to simulate a controller for functional testing of user blocks and programs.

Online access and test functions of the programming tools can be carried out in exactly the same manner as with a real controller.

This allows the entire program test to be carried out on-site in the development office.

The facility to simulate the communication via MPI, PROFIBUS DP and TCP/IP is new and ensures a high degree of flexibility in the simulation.

It should be capable of working with multi-instances from Version 5.4 SP3 and also possible to start several tasks and test several controllers simultaneously.

It should be to download simulated task into the available hardware station.

### Design and functions

It is suitable to executes the user program just like a real controller (special functions such as F technology only conditionally). During program execution, different process values can be monitored and changed via a simple user interface (e.g. switching inputs/outputs on or off).

## Link-up with an external process simulation

It should be suitable to interface is used for linking up to external process simulation systems. Dynamic access to process values is possible via this interface. The PROSIM Interface is using the COM Object and is programmable for example with the Microsoft Visual Studio C++ V6.0 and the Microsoft Visual C++ .NET.

## Electrical Simulation Platform

Electric (IEC and JIC):-7 segment display ,Coder ,Fuse ,Heating element ,Sound signalling hooter ,Thermal relay with safety contact ,Voltmeter ,Block ,2 positions switch ,3 positions switch ,Contact NC ,ContactNO,Contact with off

delay NC ,Contact with off delayNO ,Contact with on delay NC ,Contact with on delayNO ,Contact with on-off delay NC ,Contact with on-off delayNO ,Disconnecting switch with fuse ,Disconnecting switch

with switch ,Disconnecting switch ,Magnetothermal disconnecting switch circuit breaker ,Position switch NC ,Position switch NO ,Power contact NO ,Proximity switch NC ,Proximity switch NO ,Push button NC ,Push button NO ,Switch NC ,Switch NO ,Thermal disconnecting switch circuit breaker ,Jump ,Label ,Ac variable speed transmission ,Dc variable speed transmission ,Motor DC current ,Single phase motor

,Three phase motor on single phase source 1 ,Three phase motor on single phase source 2 ,Three phase motor starting star triangle ,Three phase motor with two speed ,Three phase motor ,Coil latch (reset)

,Coil latch (set) ,Coil with double pilot ,Coil with off delay ,Coil with on and off delay ,Coil with on delay ,Coil ,Light ,Solenoid ,Common (0 volt) ,DC power supply ,Ground ,Power supply 24 volts ,Power supply L1

,Power supply L2 ,Power supply L3 ,Power supply Neutral ,Transformer ,Magnetic sensor ,Proximity sensor

## 9. Digital Electronics Design Software-20Users

### Technical Specifications

Power sources, 3 to 8 coder, 4 bits comparator, 7 segment decodeur, 8 to 3 coder, BCD decoder, 4 bit asynchronous counter, Down counter, Up counter, Digital voltmeter, Logical probe, Flip-flop D, Flip-flop,Jk, Flip-flop Jkt, Flip-flop SR, Flip-flop Srt, Flip-flop T, Logical gates And, Logical gates Nand, Logical gates No, Logical gates Nor, Logical gatesOr, Logical gates Yes, Clock, Sequencer, Common(0 volt), Positive power.

### Pneumatic Simulation Platform

Air dryer ,Automatic drain coalescing filter ,Coalescing filter 1 ,Coalescing filter 2 ,Cooler ,Differential pressure gauge ,Filter and separator ,Filter ,Gas-loaded accumulator with separator ,Gas-loaded accumulator without separator ,General accumulator ,Indicator 2 ,Indicator ,Lubricator ,Manual drain coalescing filter ,Manual drain filter ,Pressure gauge ,Pressure reducer ,Silencer ,Vaccum generator ,Valve ,Motor 1 direction ,Motor 2 directions ,Rotary actuator ,Vacuum cup ,Bellow actuator ,Brake ,Double acting cylinder with sensors ,Double acting cylinder ,Single acting cylinder spring exit with sensors ,Single acting cylinder spring exit ,Single acting cylinder spring return with sensors ,Single acting cylinder spring return ,Cylinders\Small ,Cylinders\Brake\Double acting cylinder ,Cylinders\Brake\Single acting

cylinder spring exit ,Cylinders\Brake\Single acting cylinder spring return ,Cylinders\Long\Double acting cylinder ,Cylinders\Long\Single acting cylinder spring exit ,Cylinders\Long\Single acting cylinder spring return ,Cylinders\Small\Double acting cylinder ,Cylinders\Small\Single acting cylinder spring exit ,Cylinders\Small\Single acting cylinder spring return ,Directional valves 2/2 ,Directional valves 3/2 ,Directional valves 3/3 ,Directional valves 4/2 ,Directional valves 4/3 ,Directional valves 5/2 ,Directional valves 5/3 ,Check valve ,Pilot to close check valve ,Pilot to open check valve ,Quick exhaust valve ,Throttle one-way ,Throttle ,Variable throttle ,Compressor ,Exhaust ,Plug ,Pressure source ,Compressor\Compressor with three phase motor ,Compressor\Compressor ,Jump ,Label ,AND ,Counter ,INH ,NAND ,NOR ,NOT (2

inputs) ,NOT ,OR ,YES (2 inputs) ,YES ,Conditioning unit with lubricator ,Conditioning unit ,Piloted pressure regulator ,Piloted pressure relief valve ,Pressure regulator ,Pressure relief valve ,Sequence valve ,Variable pressure regulator ,Variable pressure relief valve ,Variable sequence valve ,push button NO ,push button with detent NC ,push button with detent NO ,push button NC, ,Not threshold sensor ,Pressure sensor ,Sequencers\Entry module ,Sequencers\Exit module ,Sequencers\Memory with reset activation ,Sequencers\Memory with set priority ,Sequencers\Step module ,Timer with negative output ,Timer with positive output.

### Hydraulic Simulation Platform

Accumulator ,Air cooler ,Air filter ,Cooler with thermal switch ,Cooler-heater with thermal switch ,Cooler-heater ,Cooler ,Differential pressure gauge ,Filter ,Fluid cooler with thermal switch ,Fluid cooler ,Gasloaded

accumulator without separator ,Heater ,Indicator ,Lubrificator ,Pressure gauge ,Pressure indicator ,Spring-loaded accumulator ,Valve ,Weight-loaded accumulator ,Cylinders ,Motor 1 direction



,Motor 2 directions ,Rotary cylinder ,Cylinders\Brake ,Cylinders\Double acting cylinder ,Cylinders\Long ,Cylinders\Single acting cylinder with spring exit ,Cylinders\Small ,Cylinders\Spring acting cylinder with spring return ,Cylinders\Brake\Double acting cylinder ,Cylinders\Brake\Single acting cylinder spring exit ,Cylinders\Brake\Single acting cylinder spring return ,Cylinders\Long\Double acting cylinder ,Cylinders\Long\Single acting cylinder spring exit ,Cylinders\Long\Single acting cylinder spring return ,Cylinders\Small\Double acting cylinder ,Cylinders\Small\Single acting cylinder spring exit ,Cylinders\Small\Single acting cylinder spring return ,Directional valves 2/2 ,Directional valves 3/2 ,Directional valves 3/3 ,Directional valves 4/2 ,Directional valves 4/3 ,Directional valves 5/2 ,Directional valves 5/3 ,Check valve ,Parachute valve ,Pilot operated check valve ,Pilot to close check valve ,Spring loaded check valve ,Throttle valve ,Variable throttle valve ,Plug ,Pressure source ,Reservoir ,Jump ,Label ,Counterbalance valve ,Piloted counterbalance valve ,Piloted pressure reducing valve ,Piloted pressure relief valve ,Pressure reducing valve ,Pressure relief valve ,Sequence valve ,Variable counterbalance valve ,Variable pressure reducing valve ,Variable pressure relief valve ,Variable sequence valve ,Pressure sensor.

## **10. Computer Aided E-learning solution for Electrical drives and Engine Simulation for E-Mobility Electrical Drive Learning -20Users-05 Year Subscriptions**

### Technical Specifications

Computer Aided E-Learning platform should be required for Automotive essential and electrical drives for E-vehicles with self-learning concept and following features,

Bidder should be launching smart brand new simulator platform.

With the aid of virtual oscilloscopes, multimeters and other tools, a user can carry out countless actions in this virtual engine management system.

The simulator has pre-defined and programmable faults that can be assigned.

The Simulator will expand beyond engine diagnostics to have simulation exercises for the entire vehicle.

In addition to lessons, tasks and tests for every subject area, users will also have diagnostic simulation exercises.

Resolves the reading comprehension problems caused by text books.

Exercises critical thinking and problem-solving skills.

Engages and stimulates students Visually demonstrates the inner working of components

Can be used in front of the class, for homework and in computer labs.

Hundreds of modules to choose from Contains the latest developments in automotive technology Real time reporting

Allows for virtual practice sessions before practical exercises.

No more text books!

Apply their gaming skills to learning

It is about understanding, not memorizing Speeds up the learning process and is a fun way to learn

Merges the theoretical with the practical Visually demonstrates how components and their inner workings function

Students can learn at their own pace Practice when, where, and as often as they like.

The lesson modules in are theory content units which have been developed by .

The lesson modules in are theory content units.

These have been created by game designers based on the educational principle of guided self-discovery.

An increasing number of schools are completely replacing textbooks.

Engine Simulator

1 Customizable Cases for Simulator- Endless number of topics/ issues

Few of the topics configured in the module for reference are,

a Electude Simulator - Body damage to right front recently repaired

b Electude Simulator - 'Check Engine' light comes on

c Electude Simulator - Engine doesn't run smoothly

d Electude Simulator - Engine doesn't run smoothly; stalls often

e Electude Simulator - Engine overheated while driving

f Electude Simulator - Engine stalled while driving and won't restart

g Electude Simulator - Engine won't warm to operating temperature

h Electude Simulator - Showroom car won't start

i Electude Simulator - Vehicle had a fire under the hood.

j Electude Simulator - Engine Management.

E- Learning platform should be required for Automotive essential and electrical drives for E-vehicles with self-learning concept and following features,

Bidder should be launching smart brand new simulator platform.

With the aid of virtual oscilloscopes, multimeters and other tools, a user can carry out countless

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Allows for virtual practice sessions before practical exercises.

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Electric Drive

1 Electric Drive: Working on Hybrids

2 Electric Drive: Working on Hybrids Quiz

3 Electric Drive: Safety Systems Quiz

4 Electric Drive: Introduction - Efficiency Quiz

5 Electric Drive: Resolver Quiz

- 6 Electric Drive: Rotating Magnetic Field Quiz
- 7 Electric Drive: Synchronous Motor with Permanent Magnets Quiz
- 8 Electric Drive: Cables Quiz
- 9 Electric Drive: Charging Quiz
- 10 Electric Drive: Introduction - Categories Quiz
- 11 Electric Drive: Introduction - Configurations Quiz
- 12 Electric Drive: Introduction - Foundations Quiz
- 13 Electric Drive: Introduction - Operation Quiz
- 14 Electric Drive: Safety Systems
- 15 Electric Drive: Resolver
- 16 Electric Drive: Rotating Magnetic Field
- 17 Electric Drive: Charging
- 18 Electric Drive: Synchronous Motor with Permanent Magnets
- 19 Electric Drive: Cables
- 20 Electric Drive: Introduction – Categories
- 21 Electric Drive: Introduction – Configurations
- 22 Electric Drive: Introduction – Operation
- 23 Electric Drive: Introduction – Efficiency

### 11. Data Acquisition/Control Unit (PC interface unit) ,

Data acquisition unit with 8 analogue channels. Equipped with 2 relays and 2 analogue outputs. It is possible to acquire continuous signals or slowly variable up to 100Hz

- Direct power supply from USB, total consumption less than 100mA., • 2 relay outputs. • 2 analogue outputs, with: - Serial D/A converter 8 bit, Output levels: -10/+10 V, • 8 analogue inputs, with (Input levels: -10/+10 V, High impedance input amplifier, A/D converter 12 bit, Self-calibration and self zeroing, Max speed of conversion: 10 kHz

- Driver for Windows 98, Me, 2000, and XP

Data Acquisition & Processing Software:

Data Acquisition Software for acquiring data into PC having two sections

FAULT SIMULATORS:

Set of 4 masks to insert simulated faults in the machines of the system. The set including:

- Fault Simulator for a Three Phase Cage Motor : Short Circuit between two Phases / Break-up of stator phase / Break-up of two phases / Internal short-circuit.
- Fault Simulation for a Dahlander Motor: Short-circuit between two phases, Break-up of a stator phase, Internal short-circuit.
- Fault Simulator for a single-Phase Capacitor Motor - Unsuccessful starting of the motor
- Fault Simulator for a Compound excited DC motor - Unsuccessful starting of the motor, Break-up of a stator phase Shunt excitation circuit reversal.
- 10 Sets of Technical and User manual.

## 12. Electrical Drive System

Electrical Drive System should be a universal and standalone training set up with learning facility for Basic Electrical and AC/DC machine with all necessary equipment's with E-learning software.

All Components should be in a modular form for easy to assembled and disassembled in open structure .

System should be a having facility to work minimum 04 nos. Students at time on one station (Two on front side and Two on rare side). The details specification of the system are as follows: -

Electrical Dirve Open Lab System should be a floor mounted and made up of Aluminium profiles (40X40) mm Minimum. Table top with MDF material is with minimum dimensions of 1500mm x 1200mm x 35mm (Thickness) on which two students can work at a time back-to-back.

Four revolving wheels should be provided for easy movement.

Aluminium profile based separate working area is provided in some is in open and some in vertical panel to mount the electrical components/tools which are required at the time of practical.

Top of workstation is MDF based material with 35MM thick with four- drawers in MDF with with dimension of (wd-400mm x D-450mm x Ht- 550mm) Minimum on right side.

All electrical components are mounted on the vertical Aluminium panel. All Electrical Open lab material are available in modular and independent form for step by step learning Panel.The system includes following list of instrument on a panel,

### 1.MOTOR DRIVEN POWER SUPPLY UNIT :

Suitable for supplying variable alternate and rectified direct current, in order to carry on easily all the tests on the electric machines of the laboratory and in general in an electric measuring laboratory. Provided with start push- button with remote control switch, stop push- button, key- unlocked emergency mushroom head push- button and differential magnetothermal protection on the main sockets. Connector for overspeed protection of the motors. Manual control or automatic control through PC interface unit.. The control devices and the connecting terminals are arranged on the front panel. & shall have following features:

- Output voltages (\* programmable)
- variable ac: 3 x 0 - 46 V. 10 A (\*)
- 3 x 0 - 26 V. 14 A \*
- standard fixed ac: 220 V, 10 A
- variable dc: 0 - 46 V, 14 A \*
- 0 - 32 V, 14 A \*

- 0 - 42 V, 5 A
- Power supply: 3 x 380 V + N, 50/60 Hz.

## 2. MECHANICAL POWER DIGITAL MEASURING UNIT :

Suitable for direct measurement of motor output torque through load cell and of rotating speed through optical transducer, with mechanical power display; provided with direct current variable power supply for the excitation of the braking systems. Digital readout of measured quantities and conditioning to voltage levels directly compatible with plotters. Interface able for data acquisition and automatic plotting of the electromechanical characteristics of the machines. Connector for over speed protection of motors for connection to power supply unit. Shall have following Specifications:

Torque: .999 Nm (1 mV/dgt) , Speed: 6000 rpm (1 mV/rpm), Power: 300 W (1 mV/W), Dc output: 0 - 36 V, 2 A, Power supply: 220 V, 50/60 Hz

## 3.LOAD CELL :

Resistance electronic strain-gauge with 100 N range, to be mounted on the brake unit for measuring the mechanical torque.

## 4.ELECTRIC POWER DIGITAL MEASURING UNIT :

Suitable for electric power measurement both in direct and alternate current, single or three-phase, also with unbalanced loads. Provided with: digital voltmeter and ammeter for dc measurements; digital voltmeter and ammeter switchable to the different phases and digital wattmeter single-three phase for ac measurements. Analog outputs proportional to the measured quantities and directly compatible with plotters or interface able for automatic plotting of the characteristic curves of the machines

## 5.SEMI- AUTOMATIC TEST AND MEASUREMENT SYSTEM:

It is necessary to use the interface unit and a personal computer with the software and other necessary accessories. Specifications:

Dc voltage: 50 V (10 mV/V), Dc current: 9.99 A (250 mV/A), Ac voltage: 60 V (10 mV/V), Ac current: 9.99 A (250 mV/A), Ac power: 999 W (1 mV/W), Power supply: 220 V, 50/60 Hz

## 6.MOTOR DRIVEN RESISTIVE LOAD UNIT :

Suitable to realize single or three- phase resistive loads with manual operation or automatic operation through PC interface unit

Resistance: 3 x 60 Ohm, Series resistance: 3 x 7.2 Ohm, Current: 3 x 3.3 A, Power supply: 220 V, 50/ 60 Hz.

## 7.ADAPTER BRACKET:

To be fix on the baseplate; allow the the coupling of the electromagnetic brake with the machine under test.

#### 8.POLE CHANGING UNIT:

Switch to change the pole number on Dahlander two-speed motor.

#### 9.LOCKING AND ROTATABLE DEVICE:

Necessary for locking and rotating the rotor of the slip ring asynchronous motor.

#### 10.PARALLEL BOARD:

Rotating light synchronoscope provided with fuses and switch to perform the parallel connection between generators or between the alternator and the mains.

#### 11. ELECTROMAGNETIC BRAKE:

Brake for testing motors with power up to 300W. Shall be provided with symmetrical coupling semi-joint and educational/ terminal board on which a clear synoptically must be shown.

- Max. voltage : 24 V, - Max. current : 1,5 A, - Max. speed : 4000 rpm, - Complete with arms, weights and balancing level.

#### 12.STARTING AND SYNCHRONIZATION UNIT :

Rotor starter for three-phase slip ring motors and excitation device for synchronization with the mains. Power supply: 220 V, 50/60 Hz.

Star/Delta Starter : For Three phase squirrel cage induction motors.

#### 13, MOTOR DRIVEN POWER SUPPLY FOR BRAKE:

Suitable to supply with variable voltage the brake assemblies with manual operation or automatic operation through PC interface unit Dc output: 0 - 48 V, 2 A max, Power supply: 220 V, 50/60 Hz.

14.Scope of Technical Data-10 Sets of Technical and User manual.



### **13. Electrical Motor Open Lab System**

Electrical Motor Open Lab System should be a universal and standalone training set up with learning facility for Basic Electrical and AC/DC machine with all necessary equipment's with E-learning software.

All Components should be in a modular form for easy to assembled and disassembled in open structure .

System should be a having facility to work minimum 04 nos. Students at time on one station (Two on front side and Two on rare side). The details specification of the system are as follows: -

Electrical Dirve Open Lab System should be a floor mounted and made up of Aluminium profiles (40X40) mm Minimum. Table top with MDF material is with minimum dimensions of 1500mm x 1200mm x 35mm (Thickness) on which two students can work at a time back-to-back.

Four revolving wheels should be provided for easy movement. Latest Computer with monitor mounting facility should be also provided on the left side basement of system with adjustable movable arrangement and up-down facility.

Aluminium profile based separate working area is provided in some is in open and some in vertical panel to mount the electrical components/tools which are required at the time of practical.

Top of workstation is MDF based material with 35MM thick with four- drawers in MDF with with dimension of (wd-400mm x D-450mm x Ht- 550mm) Minimum on right side.

All electrical components are mounted on the vertical Aluminium panel. All Electrical Open lab material are available in modular and independent form for step by step learning Panel.

Desk Top should be a latest/compatible with Processor/latest, Monitor of 21" , Bluetooth Keyboard and Mouse, 500GB Hard Disk, 8 GB RAM. Touchscreen facility and windows-single user license copy.

#### **ELECTRICAL OPEN LAB**

It should be open type learning hardware for Electrical Open Lab with dissectible Experimental rotating machines with data acquisition control system with PC based Software.

Specifications: -

Fully Dissectible Experimental Rotating Machine set : The system is a component kit that should allow to assemble the rotating electrical machines, both for AC/DC, leaving the student the possibility of a personal critical realization with the purpose of a real knowledge of the various constructive techniques. Whole unit should to assembled & disassembled very easily. It Should consist of:

1. Base plate,
2. four removable bearing housing,
3. coupling,

4. elastic buffer,
5. Electrical speed transducer,
6. clamping screws, keys,
7. DC stator with salient poles,
8. AC stator with three-phase winding,
9. commutator rotor,
10. brush holder with two brushes,
11. squirrel cage rotor,
12. Slip-ring rotor & brush holder with 3+3 brushes.

The above systems should be includes motor design capabilities with provision to study various kinds of motors, as listed below, with respect to Assembly, operation and tests on electrical machines

1. Separately shunt, series and compound excited dc motors
2. Separately shunt, series and compound excited dc generators
3. Induction motors
4. Three-phase slip ring and
5. Three-phase slip ring squirrel cage,
6. Split Phase motor
7. single-phase repulsion and with capacitor
8. Dahlander connection
9. Three-phase synchronous motor
10. Induction regulator and phase transformer
11. Alternator
12. Universal motor
13. Single phase series motor
14. Repulsion motor

Scope of Technical Data-10 Sets of Technical and  
User manual.

#### **14. LMS based E-learning solution for automotive essentials for E-Mobility Automotive Essential Learning Tool-20Users-05 Year Subscriptions**

Technical Specifications

LMS based Learning platform should be required for Automotive essential and electrical drives for E-vehicles with self-learning concept and following features,

Bidder should be launching smart brand new simulator platform.

With the aid of virtual oscilloscopes, multimeters and other tools, a user can carry out countless actions in this virtual engine management system.

The simulator has pre-defined and programmable faults that can be assigned.

The Simulator will expand beyond engine diagnostics to have simulation exercises for the entire vehicle.

In addition to lessons, tasks and tests for every subject area, users will also have diagnostic simulation exercises.

Resolves the reading comprehension problems caused by text books.

Exercises critical thinking and problem-solving skills.

Engages and stimulates students Visually demonstrates the inner working of components

Can be used in front of the class, for homework and in computer labs.

Hundreds of modules to choose from Contains the latest developments in automotive technology Real time reporting

Allows for virtual practice sessions before practical exercises.

No more text books!

Apply their gaming skills to learning

It is about understanding, not memorizing Speeds up the learning process and is a fun way to learn

Merges the theoretical with the practical Visually demonstrates how components and their inner workings function

Students can learn at their own pace Practice when, where, and as often as they like.

The lesson modules in are theory content units which have been developed by .

The lesson modules in are theory content units.

These have been created by game designers based on the educational principle of guided self-discovery.

An increasing number of schools are completely replacing textbooks.

The Learning Modules should be as follows: -Automotive Essentials Module Instruments and Tools related:

1 Ammeter

2 Ammeter Quiz

3 Antifreeze Gauge

4 Antifreeze Gauge Quiz

5 Chisels, Pin Punches and Center Punches

6 Chisels, Pin Punches and Center Punches Quiz

7 Combustion Leak Detector

8 Combustion Leak Detector Quiz

9 Coolant Pressure Tester

10 Coolant Pressure Tester Quiz

11 Current Clamp

12 Current Clamp Quiz

13 Floor Jack

14 Floor Jack Quiz

15 Hammers

16 Hammers Quiz

17 Headlight Aimer

18 Headlight Aimer Quiz

19 Hydrometer

20 Hydrometer Quiz

21 Jack Stand

22 Jack Stand Quiz

23 Measuring Tread Depth

24 Measuring Tread Depth Quiz

25 Micrometer

26 Micrometer Quiz

27 Multimeter Auto Range

28 Multimeter Auto Range Quiz  
29 Nuts and Bolts  
30 Nuts and Bolts Quiz  
31 Ohmmeter  
32 Ohmmeter Quiz  
33 Oscillograph  
34 Oscillograph Quiz  
35 Oscilloscope: Exercises  
36 Oscilloscope: Exercises Quiz  
37 Oscilloscope: Guided Tour  
38 Oscilloscope: Guided Tour Quiz  
39 Oscilloscope: Introduction  
40 Oscilloscope: Introduction Quiz.  
41 Oscilloscope: Step-by-Step Plan  
42 Oscilloscope: Using Two Channels  
43 Oscilloscope: Using Two Channels Quiz  
44 Plastigage  
45 Plastigage Quiz  
46 Pliers  
47 Pliers Quiz  
48 Pneumatic Impact Wrench  
49 Pneumatic Impact Wrench Quiz  
50 Pop Rivets  
51 Pop Rivets Quiz  
52 Ratchets  
53 Ratchets Quiz  
54 Screwdrivers  
55 Screwdrivers Quiz  
56 Tire Pressure Gauge

57 Tire Pressure Gauge Quiz  
58 Torque Wrench  
59 Torque Wrench Quiz  
60 Vehicle Lifts  
61 Vehicle Lifts Quiz  
62 Vernier Caliper  
63 Vernier Caliper Quiz  
64 Voltmeter  
65 Voltmeter Quiz  
66 Wheel Balancing Machine  
67 Wheel Balancing Machine Quiz  
68 Wrenches  
69 Wrenches Quiz.  
Physics  
70 Angle  
71 Angle Quiz  
72 Calculating Rotational Frequency  
73 Calculating Rotational Frequency Quiz  
74 Calculating Speed  
75 Calculating Speed Quiz  
76 Converting Length, Surface Area and Volume  
77 Converting Length, Surface Area and Volume Quiz  
78 Electromagnetism  
79 Electromagnetism Quiz  
80 Forces Exerted on a Tire When Cornering  
81 Forces Exerted on a Tire When Cornering Quiz  
82 Friction  
83 Friction Quiz.  
85 Ideal Gas Law Quiz

86 Increasing Force Using Hydraulics  
87 Increasing Force Using Hydraulics Quiz  
88 Induction  
89 Induction Quiz  
90 Kirchhoff's First Law  
91 Kirchhoff's First Law Quiz  
92 Longitudinal Forces On a Vehicle  
93 Longitudinal Forces On a Vehicle Quiz  
94 Lorentz Force  
95 Lorentz Force Quiz  
96 Magnetism  
97 Magnetism Quiz  
98 Movement Advanced  
99 Movement Advanced Quiz  
100 Ohm's Law  
101 Ohm's Law Quiz  
102 Pascal's Law  
103 Pascal's Law Quiz  
104 Pressure  
105 Pressure Quiz  
106 Spring Characteristics  
107 Spring Characteristics Quiz  
108 Torque  
109 Torque Quiz  
110 US Standard and Metric Conversion  
111 US Standard and Metric Conversion Quiz  
112 Vibration Damping  
113 Vibration Damping Quiz  
114 Watt's Law

115 Watt's Law Quiz

Maintenance related:

116 Changing Oil

117 Changing Oil Quiz

118 Checking Oil Level

119 Checking Oil Level Quiz

120 Clutch Disc Maintenance

121 Clutch Disc Maintenance Quiz

122 Cooling System Monitoring: Instrumentation

123 Cooling System Monitoring: Instrumentation Quiz

Sustainability:

124 Alternative Fuels

125 Alternative Fuels Quiz

126 Electric Drive: Introduction - Categories

127 Electric Drive: Introduction - Configurations

128 Electric Drive: Introduction - Efficiency

129 Electric Drive: Introduction - Foundations

130 Electric Drive: Introduction - Operation

131 European Standards

132 European Standards Quiz

133 Exhaust Gases and Catalysts

134 Exhaust Gases and Catalysts Quiz

135 Greenhouse Effect

136 Greenhouse Effect Quiz

137 Introduction to Hybrids

138 Introduction to Hybrids Quiz

139 Kyoto Protocol

140 Kyoto Protocol Quiz

141 Parallel Hybrid



142 Parallel Hybrid Quiz  
143 Series Hybrid  
144 Series Hybrid Quiz  
145 Series/Parallel Hybrid  
146 Series/Parallel Hybrid Quiz  
147 Working on Hybrid Vehicles  
148 Working on Hybrid Vehicles Quiz

Safety and Environment:

149 Fire Safety  
150 Globally Harmonized System (GHS)  
151 Personal Protective Equipment (PPE)  
152 Safety Signs

Engines:

153 2-Stroke Piston Engine  
154 2-Stroke Piston Engine Quiz  
155 4-Stroke Piston Engine  
156 4-Stroke Piston Engine Quiz  
157 Air Filters  
158 Air Filters Quiz  
159 Air Mass  
160 Air Mass Quiz  
161 Camshaft  
162 Camshaft Adjustment  
163 Camshaft Adjustment Quiz.  
164 Camshaft Quiz  
165 Catalytic Converters  
166 Catalytic Converters Quiz

167 Combined Heat and Power System  
168 Combined heat and power system quiz  
169 Compression Ratio  
170 Compression Ratio Quiz  
171 Connecting Rod  
172 Connecting Rod Quiz  
173 Crankcase Ventilation  
174 Crankcase Ventilation Quiz  
175 Crank-Connecting Rod Mechanism  
176 Crank-Connecting Rod Mechanism Quiz  
177 Crankshaft  
178 Crankshaft Quiz  
179 Cylinder Head  
180 Cylinder Head Quiz  
181 Diesel Engine  
182 Diesel Engine Quiz  
183 Engine Block  
184 Engine Block Quiz  
185 Engine Block Types  
186 Engine Block Types Quiz  
187 Engine Mechanical Components  
188 Engine Mechanical Components Quiz  
189 Engine Performance Graph  
190 Engine Performance Graph Quiz  
191 Exhaust Gases  
192 Exhaust Gases Quiz  
193 Exhaust System  
194 Exhaust System Quiz  
195 Flywheel

196 Flywheel Quiz  
197 Forced Induction  
198 Forced Induction Quiz  
199 Fossil Fuels  
200 Fossil Fuels Quiz  
201 Gasoline Engine: Otto Cycle  
202 Gasoline Engine: Otto Cycle Quiz  
203 Lambda  
204 Lambda Quiz.  
205 Manifolds  
206 Manifolds Quiz  
207 Micrometer  
208 Micrometer Quiz  
209 Piston Bore Offset  
210 Piston Bore Offset Quiz  
211 Piston Engines  
212 Piston Engines Quiz  
213 Piston Movement  
214 Piston Movement Quiz  
215 Pistons  
216 Pistons Quiz  
217 Piston Velocity  
218 Piston Velocity Quiz  
219 Plastigage  
220 Plastigage Quiz  
221 Power Diagram  
222 Power Diagram Quiz  
223 Serpentine Belt  
224 Serpentine Belt Quiz

225 Stroke Volume  
226 Stroke Volume Quiz  
227 Timing System  
228 Timing System Quiz  
229 Torque Wrench  
230 Torque Wrench Quiz  
231 Torsional Vibration Dampener  
232 Torsional Vibration Dampener Quiz  
233 Valve Operation  
234 Valve Operation Quiz  
235 Valves  
236 Valves Quiz  
237 Vernier Caliper  
238 Vernier Caliper Quiz  
239 Wankel Engine  
240 Wankel Engine Quiz  
Transmission and Clutch:  
241 Automatic Transmission Control  
242 Automatic Transmission Control Quiz  
243 Automatic Transmission Gear Ranges  
244 Automatic Transmission Gear Ranges Quiz  
245 Automatic Transmission Overview  
246 Automatic Transmission Overview Quiz  
247 Bearings  
248 Bearings Quiz  
249 Clutch Disc  
250 Clutch Disc Maintenance  
251 Clutch Disc Maintenance Quiz  
252 Clutch Disc Quiz

253 Clutch Pressure Plate Assembly  
254 Clutch Pressure Plate Assembly Quiz  
255 Clutch Release Bearing  
256 Clutch Release Bearing Quiz  
257 Commercial Vehicle Power Train  
258 CV Joints  
259 CV Joints Quiz  
260 Differential  
261 Differential Quiz  
262 Drive Shaft  
263 Drive Shaft Quiz  
264 Drive Train Calculations  
265 Drive Train Calculations Quiz  
266 Drive Train Configuration  
267 Drive Train Configuration Quiz  
268 Engine Performance Graph  
269 Engine Performance Graph Quiz  
270 Flywheel  
271 Flywheel Quiz  
272 Gear Ratio  
273 Gear Ratio Graph  
274 Gear Ratio Graph Quiz  
275 Gear Ratio Quiz  
276 Gear Types  
277 Gear Types Quiz  
278 Longitudinal Forces On a Vehicle  
279 Longitudinal Forces On a Vehicle Quiz  
280 Manual Transmission  
281 Manual Transmission: Power Flow

282 Manual Transmission: Power Flow Quiz

283 Manual Transmission Quiz

284 Manual Transmission Shafts

285 Manual Transmission Shafts Quiz

286 Movement Advanced

287 Movement Advanced Quiz

288 Multi-Plate Clutch Automatic Transmission

289 Multi-plate Clutch Automatic Transmission Quiz

290 Multi-Plate Clutch Calculations

291 Multi-plate Clutch Calculations Quiz

292 Operating the Clutch

293 Operating the Clutch Quiz

294 Operating the Transmission

295 Operating the Transmission Quiz

296 Planetary Gear Sets

297 Planetary Gear Sets Quiz

298 Single Dry-Disc Clutch

299 Single Dry-Disc Clutch Quiz

300 Single Planetary Gear Set

301 Single Planetary Gear Set: Introduction

302 Single Planetary Gear Set: Introduction Quiz

303 Single Planetary Gear Set Quiz

304 Synchronizer

305 Synchronizer Quiz

306 Torque Converter

307 Torque Converter Quiz

308 Transmission Brake Band

309 Transmission Brake Band Quiz

310 Universal Joint

311 Universal Joint Quiz

Wheels and tires:

312 Flat Tire and Emergency Assistance

313 Flat Tire and Emergency Assistance Quiz

314 Forces Exerted on a Tire When Cornering

315 Forces Exerted on a Tire When Cornering Quiz

316 Longitudinal Forces On a Vehicle

317 Longitudinal Forces On a Vehicle Quiz

318 Measuring Tread Depth

319 Measuring Tread Depth Quiz

320 Tire Pressure Gauge

321 Tire Pressure Gauge Quiz

322 Tire Radius

323 Tire Radius Quiz

324 Tires

325 Tire Sizes and Designations

326 Tire Sizes and Designations Quiz

327 Tires Quiz

328 Tire Wear

329 Tire Wear Quiz

330 Valve Stem

331 Valve Stem Quiz

332 Wheel Balancing Machine

333 Wheel Balancing Machine Quiz

334 Wheel Imbalance

335 Wheel Imbalance Quiz

336 Wheels

337 Wheels Quiz

Brakes:

338 Brake Booster  
339 Brake Booster Quiz  
340 Brake Caliper  
341 Brake Caliper Quiz  
342 Brake Disc  
343 Brake Disc Quiz  
344 Brake Fluid  
345 Brake Fluid Level Sensor  
346 Brake Fluid Level Sensor Quiz  
347 Brake Fluid Quiz  
348 Brake Lines and Hoses  
349 Brake Lines and Hoses Quiz  
350 Brake Pads  
351 Brake Pads Quiz  
352 Brake Pedal Force and Hydraulic Brake Force  
353 Brake Pedal Force and Hydraulic Brake Force Quiz  
354 Brake Pressure Limiter and Brake Proportioning Valve  
355 Brake Pressure Limiter and Brake Proportioning Valve Quiz  
356 Brake System: Introduction  
357 Brake System: Introduction Quiz  
358 Disc Brakes  
359 Disc Brakes Quiz  
360 Drum Brake: Introduction  
361 Drum Brake: Introduction Quiz  
362 Drum Brakes  
363 Drum Brakes Quiz  
364 Friction  
365 Friction Quiz  
366 Increasing Force Using Hydraulics



367 Increasing Force Using Hydraulics Quiz

368 Master Cylinder

369 Master Cylinder Quiz

370 Movement Advanced

371 Movement Advanced Quiz

372 Movement Basic

373 Movement Basic Quiz

374 Parking Brake

375 Parking Brake Quiz

376 Pascal's Law

377 Pascal's Law Quiz

378 Pressure

379 Pressure Quiz

Suspension:

380 Ackermann Steering Geometry

381 Ackermann Steering Geometry Quiz

382 Alignment Report and Adjustment

383 Alignment Sequence

384 Alignment Sequence Quiz

385 Angle

386 Angle Quiz

387 Axle Load

388 Axle Load Quiz

389 Camber

390 Camber Quiz

391 Caster

392 Caster Quiz

393 Converting Angles

394 Converting Angles Quiz

395 Dependent Suspension  
396 Dependent Suspension Quiz  
397 Dynamic Camber  
398 Dynamic Camber Quiz  
399 Dynamic Steering Axis Inclination  
400 Dynamic Steering Axis Inclination Quiz  
401 Dynamic Toe Angle  
402 Dynamic Toe Angle Quiz  
403 Electric Power Steering  
404 Electric Power Steering Quiz  
405 Hydraulic Power Steering  
406 Hydraulic Power Steering Quiz  
407 Independent Suspension  
408 Independent Suspension Quiz  
409 Longitudinal Forces On a Vehicle  
410 Parallelogram (Indirect) Steering System  
411 Parallelogram (Indirect) Steering System Quiz  
412 Preparation for Alignment  
413 Preparation for Alignment Quiz  
414 Rack and Pinion (Direct) Steering System  
415 Rack and Pinion (Direct) Steering System Quiz  
416 Semi-Independent Suspension  
417 Semi-Independent Suspension Quiz  
418 Shock Absorber: Introduction  
419 Shock Absorber: Introduction Quiz  
420 Shock Absorbers  
421 Shock Absorber: Single Cylinder  
422 Shock Absorber: Single Cylinder Quiz  
423 Shock Absorbers Quiz

424 Shock Absorber: Twin Cylinder  
425 Shock Absorber: Twin Cylinder Quiz  
426 Spring Characteristics  
427 Spring Characteristics Quiz  
428 Springs  
429 Springs: Introduction  
430 Springs: Introduction Quiz  
431 Springs Quiz  
432 Steering Axis Inclination (SAI)  
433 Steering Axis Inclination (SAI) Quiz  
434 Steering System  
435 Steering System Quiz  
436 Subframe  
437 Subframe Quiz  
438 Thrust Angle  
439 Thrust Angle Quiz  
440 Tie Rod Length and Angle Difference  
441 Tie Rod Length and Angle Difference Quiz  
442 Toe Angle  
443 Toe Angle Quiz  
444 Vehicle Dimensions  
445 Vehicle Dimensions Quiz  
446 Vehicle Movements  
447 Vehicle Movements Quiz  
448 Vibration Damping  
449 Vibration Damping Quiz  
450 Wheel Linkage and Stabilizers  
451 Wheel Linkage and Stabilizers Quiz  
452 Wheel Suspension

453 Wheel Suspension: Introduction  
454 Wheel Suspension: Introduction Quiz  
455 Wheel Suspension Quiz  
456 Wheel Suspension Springs  
457 Wheel Suspension Springs Quiz  
AC  
458 Air Conditioning: Coupling and Lubrication  
459 Air conditioning: Coupling and Lubrication Quiz  
460 Air Conditioning: Fixed Metering  
461 Air Conditioning: Fixed Metering Quiz  
462 Air Conditioning: Switches and Sensors  
463 Air conditioning: Switches and Sensors Quiz  
464 Air Conditioning: Variable Metering  
465 Air Conditioning: Variable Metering Quiz  
466 Climate Control: Accumulator  
467 Climate Control: Accumulator Quiz  
468 Climate Control: Basics  
469 Climate Control: Basics Quiz  
470 Climate Control: Compressor  
471 Climate Control: Compressor Quiz  
472 Climate Control: Condenser  
473 Climate Control: Condenser Quiz  
474 Climate Control: Evaporator  
475 Climate Control: Evaporator Quiz  
476 Climate Control: Filter Drier  
477 Climate Control: Filter Drier Quiz  
478 Climate Control: Metering Principles  
479 Climate Control: Metering Principles Quiz  
480 Climate Control: Operation

481 Climate Control: Operation Quiz  
482 Climate Control: Working Principle  
483 Climate Control: Working Principle Quiz  
Safety and Systems:  
484 Acceleration Sensor  
485 Acceleration Sensor Quiz  
486 Active Head Restraint  
487 Active Head Restraint Quiz  
488 Active Hood Hinges  
489 Active Hood Hinges Quiz  
490 ESC/ABS: Braking Circuit  
491 ESC/ABS: Braking Circuit Quiz  
492 ESC/ABS: Characteristics  
493 ESC/ABS: Characteristics Quiz  
494 ESC/ABS: High Pressure Pump  
495 ESC/ABS: High Pressure Pump Quiz  
496 ESC/ABS: Inductive Wheel Speed Sensor  
497 ESC/ABS: Inductive Wheel Speed Sensor Quiz  
498 ESC/ABS: MRE Wheel Speed Sensor  
499 ESC/ABS: MRE Wheel Speed Sensor Quiz  
500 ESC/ABS: Overview  
501 ESC/ABS: Overview Quiz  
502 ESC: Active Brake Booster  
503 ESC: Active Brake Booster Quiz  
504 ESC: Intervention  
505 ESC: Intervention Quiz  
506 ESC: Operating Conditions  
507 ESC: Operating Conditions Quiz  
508 Hybrid Airbag

509 Hybrid Airbag Quiz

510 Seat Belt

511 Seat Belt Quiz

512 Seat Belt Tensioner

513 Seat Belt Tensioner Quiz

514 SRS: Airbag Activation

515 SRS: Airbag Activation Quiz

516 SRS: Airbags

517 SRS: Airbags Quiz

518 SRS: Dual-Stage Airbag

519 SRS: Dual-Stage Airbag Quiz

520 SRS: Gas Generator

521 SRS: Gas Generator Quiz

522 SRS: Seat Occupancy Sensor

523 SRS: Seat Occupancy Sensor Quiz

524 SRS: Seat Occupancy Switch

525 SRS: Seat Occupancy Switch Quiz

526 SRS: Seat Position Sensor

527 SRS: Seat Position Sensor Quiz

528 SRS: Working on Airbags

529 SRS: Working on Airbags Quiz

Lighting

530 Cornering Lights

531 Cornering Lights Quiz

532 European Legal Regulations for Lights (UNCE)

533 European Legal Regulations for Lights (UNCE) Quiz

534 Headlight Aimer

535 Headlight Aimer Quiz

536 Headlight Cleaning Systems

537 Headlight Cleaning Systems Quiz  
538 Headlight Height Adjustment  
539 Headlight Height Adjustment Quiz  
540 Headlights  
541 Headlights Quiz  
542 Lighting  
543 Lighting Quiz  
544 Light Sources  
545 Light Sources Quiz  
546 Tail Lights  
547 Tail Lights Quiz  
Cooling System  
548 Antifreeze Gauge  
549 Antifreeze Gauge Quiz  
550 Combined Heat and Power System  
551 Combined heat and power system quiz  
552 Combustion Leak Detector  
553 Combustion Leak Detector Quiz  
554 Coolant Pressure Tester  
555 Coolant Pressure Tester Quiz  
556 Cooling  
557 Cooling Quiz  
558 Cooling System Monitoring: Instrumentation  
559 Cooling System Monitoring: Instrumentation Quiz  
560 Electric Thermostat  
561 Electric Thermostat Quiz  
562 Expansion Tank  
563 Expansion Tank Quiz  
564 Heat Balance

565 Heat Balance Quiz  
566 Heater Core  
567 Heater Core Quiz  
568 Mechanical Water Pump  
569 Mechanical Water Pump Quiz  
570 Pressure Cap  
571 Pressure Cap Quiz  
572 Radiator  
573 Radiator Quiz  
574 Sankey Diagram: Power Loss  
575 Sankey Diagram: Power Loss Quiz  
576 Thermostat  
577 Thermostatically Controlled Fan  
578 Thermostatically Controlled Fan Quiz  
579 Thermostat Quiz  
Lubrication System  
580 Changing Oil  
581 Changing Oil Quiz  
582 Checking Oil Level  
583 Checking Oil Level Quiz  
584 Crankcase Ventilation  
585 Crankcase Ventilation Quiz  
586 Dry Sump Lubrication System  
587 Dry Sump Lubrication System Quiz  
588 Engine Oil: EU  
589 Engine Oil US  
590 Engine Oil US Quiz  
591 Lubricating Oil: Properties  
592 Lubricating Oil: Properties Quiz



593 Lubricating Oil: Types  
594 Lubricating Oil: Types Quiz  
595 Lubrication  
596 Lubrication Quiz  
597 Lubrication System  
598 Lubrication System: Oil Seals  
599 Lubrication System: Oil Seals Quiz  
600 Lubrication System: Pressure Relief Valve  
601 Lubrication System: Pressure Relief Valve Quiz  
602 Lubrication System Quiz  
603 Lubrication Types  
604 Lubrication Types Quiz  
605 Oil Cooler  
606 Oil Cooler Quiz  
607 Oil Filter  
608 Oil Filter Quiz  
609 Oil Level Sensor  
610 Oil Level Sensor Quiz.  
611 Oil Loss  
612 Oil Loss Quiz  
613 Oil Pressure Sensor  
614 Oil Pressure Sensor Quiz  
615 Oil Pump  
616 Oil Pump Quiz  
617 Oil Quality Sensor  
618 Oil Quality Sensor Quiz  
Gasoline Engines  
619 Accelerator Pedal Sensor  
620 Accelerator Pedal Sensor Quiz

621 Canister Purge Solenoid  
622 Canister Purge Solenoid Quiz  
623 Catalytic Converters  
624 Catalytic Converters Quiz  
625 COP: Coil Over Plug Ignition  
626 COP: Coil Over Plug Ignition Quiz  
627 DIS: Distributorless Ignition System  
628 DIS: Distributorless Ignition System Quiz  
629 EGR Solenoid Valve  
630 EGR Solenoid Valve Quiz  
631 Electronic Throttle Control  
632 Electronic Throttle Control Quiz  
633 Engine Temperature Sensor  
634 Engine Temperature Sensor Quiz  
635 Exhaust Gases and Catalysts  
636 Exhaust Gases and Catalysts Quiz  
637 Exhaust Gas Temperature Sensor  
638 Exhaust Gas Temperature Sensor Quiz  
639 Fuel Lift Pump  
640 Fuel Lift Pump Quiz  
641 Gasoline Engine: Otto Cycle  
642 Gasoline Engine: Otto Cycle Quiz  
643 GDI: Air Intake System  
644 GDI: Air Intake System Quiz  
645 GDI: Features  
646 GDI: Features Quiz  
647 GDI: Fuel Circuit  
648 GDI: Fuel Circuit Quiz  
649 GDI: High Pressure Pump

650 GDI: High Pressure Pump Quiz

651 GDI: Homogeneous Anti-Knock Combustion

652 GDI: Homogeneous Anti-Knock Combustion Quiz

653 GDI: Homogeneous Combustion

654 GDI: Homogeneous Combustion Quiz

655 GDI: Homogeneous Lean Combustion

656 GDI: Homogeneous Lean Combustion Quiz

657 GDI: Homogeneous Stratified Combustion

658 GDI: Homogeneous Stratified Combustion Quiz

659 GDI: Injector

660 GDI: Injector Quiz

661 GDI: Modes

662 GDI: Modes Quiz

663 GDI: Operating Conditions

664 GDI: Operating Conditions Quiz

665 GDI: Stratified Combustion

666 GDI: Stratified Combustion for Catalyst Heating

667 GDI: Stratified Combustion for Catalyst Heating Quiz

668 GDI: Stratified Combustion Quiz

669 Hall Sensor: Reference Signal

670 Hall Sensor: Reference Signal Quiz

671 Heated Oxygen Sensor

672 Heated Oxygen Sensor Quiz

673 IAC: Idle Air Control Valve

674 IAC: Idle Air Control Valve Quiz

675 Inductive Sensor

676 Inductive Sensor Quiz

677 Intake Air Temperature Sensor

678 Intake Air Temperature Sensor Quiz

679 Knock Sensor

680 Knock Sensor Quiz

681 Lambda

682 MAF: Mass Air Flow Sensor

683 MAF: Mass Air Flow Sensor Quiz

684 MAP: Manifold Absolute Pressure Sensor

685 MAP: Manifold Absolute Pressure Sensor Quiz

686 MPI: Characteristics

687 MPI: Characteristics Quiz

688 MPI: Fuel Circuit

689 MPI: Fuel Circuit Quiz

690 MPI: Injector

691 MPI: Injector Quiz

692 MPI: Operating Conditions

693 MPI: Operating Conditions - Ignition Timing

694 MPI: Operating Conditions - Ignition Timing Quiz

695 MPI: Operating Conditions Quiz

696 MPI: Overview

697 MPI: Overview Quiz

698 NOx Catalytic Converter

699 NOx Catalytic Converter Quiz

700 NOx Sensor

701 NOx Sensor Quiz

702 Oxygen Sensor: Introduction

703 Oxygen Sensor: Introduction Quiz

704 Spark Plug

705 Spark Plug Quiz

706 Speed Sensor

707 Speed Sensor Quiz

708 Stepper Motor

709 Stepper Motor Quiz

710 Three-Way Catalytic Converter

711 Three-Way Catalytic Converter Quiz

712 Throttle Position Sensor

713 Throttle Position Sensor Quiz

714 Two-Stage Catalytic Converter System

715 Two-Stage Catalytic Converter System Quiz

716 Wastegate Solenoid Valve

717 Wastegate Solenoid Valve Quiz

718 Wideband Air/Fuel Ratio Sensor

719 Wideband Air/Fuel Ratio Sensor Quiz

Diesel Engines

720 Catalytic Converters

721 Catalytic Converters Quiz

722 CRD: Characteristics

723 CRD: Characteristics Quiz

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