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Call for quotations for various Scientific Equipment and Apparatus and Software Solutions.

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 a valid PAN and GST number for supply, installation and maintenance of items listed in table below.

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Interested parties must send their quotations comprising of prices for each setup and 1-year support (as per annexure) on or before **04:00 PM, 20th March 2020** to Department of Technology, SPPU.

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

Department of Technology
Savitribai Phule Pune University
(Formerly University of Pune)
16 MAR 2020
Outward No. Tech/282/19-20

Head
Department of Technology
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ANNEXURE

Simulator Panel: Light Weight Electrical Vehicle

Sr.No.	Name of Items
1.	**Light Weight Electrical Vehicle** Specifications **Learning Objects:** This simulation panel allows the theoretical and practical study of the main circuits and components that are used in lightweight electric vehicles. The panel divided into four blocks allows an easy and comprehensive learning of the characteristics and advantages of the electric traction developed for urban needs. **General Characteristics** • Dim. mm approx (HxLxW) : 700x1000x150 - (470 with the base) • Weight approx. kg 25 • Input power supply: AC 220V±10% 50 Hz • Working temperature: -40℃ ~ +50℃. **Main Characteristics** The simulator is divided in four sections: A common part where the selector switch is located and other relevant buttons for the interaction of the simulator are placed A section for the study of the electric bicycle A section for the study of electric scooter A section for the study of electric car For all three vehicles, the simulator can analyse the normal drive operation and those that depends on the slope of the road. Furthermore, the different types of batteries available in the market and their recharging systems are also studied. This vertical frame bench-top trainer is specially designed to show to students how automotive systems work. The simulator consists of a panel operated by the support of a computer with a coloured silk-screen diagram that clearly shows the structure of the system and allows the location of the components on it. The display of the information available on the computer screen allows the continuous control of the educational system. The operational conditions can be entered by the students and the insertion of faults can be carried out through the computer by the teacher. The trainer is supplied with a CAI Software and the supported documentation guides the students to the study and the performance of the simulation exercises. All components installed and given leads are made to protect the safety of the students.

ANNEXURE

New Energy Power Battery Pack Training System

Sr.No.	Name of Items
1.	**New Energy Power Battery Pack Training System.** **Specification: -** **Learning Objects:** This demonstration panel is designed for the study of the lithium iron phosphate power battery pack. A single battery 3.2V 50AH is supplied with aluminum square case, 23 strands in total, 73.6V 50AH of total capacity (3.7 kilowatt-hour) and integrated BMS battery management system. The device gives the opportunity to develop students' ability to analyze and process of the failures of lithium iron phosphate power battery pack. **General Characteristics: -** • Dim. mm (HxLxW) : 1800x1200x1200 ▯ Weight approx. 200 kg • Input power supply: A.C. 220V ± 10% 50Hz. • Operating voltage: 12V DC. • Operating functioning temperature: -40℃ to +50℃. **Main Characteristics: -** All main components are installed on a bench, with the same electrical connection mode as in real vehicles, convenient for assembly and disassembly. Main component: • Detection control panel (with various detection terminals) • Lithium iron phosphate power battery pack • BMS Battery Management System • Display screen to show the real time details about power battery pack • Vehicle-mounted charger and charging plug • Emergency power switch • DC-DC (From 72v DC to 12v DC) converter. • Auxiliary accumulator. • Electric discharge control relay. • Movable framework. Students can learn the disassembly points and safety protection of high voltage system components during disassembling and assembling connections. It truly represents the construction and control relationship, installation position and operating parameters of key components of the lithium iron phosphate, power battery pack. It helps trainees to develop the fault analysis and processing skills about the power battery pack. **Other Characteristics:** - • a) The connecting lines can be scanned with the help of a two-dimensional code, after which, their assembly and disassembly methods and precautions can be completely demonstrated on the screen. • b) The power battery pack display is installed • on theteaching board to help students to observe the parameters in the charging and discharging process and master the control logic of the charging and discharging process and the law of parametric variation of main components. With the help of a smart switch, the control logic of charging and discharging process can be reproduced on the screen. c) The training bench consists of a bench and a teaching board. The bench is placed horizontally for installing main components while the teaching board is placed vertically and connected with the bench with screws. d) 4 wheels are mounted for moving flexibly, which also have self-lock device for fixing position. e) The top cover of power battery pack is transparent so students can observe the internal structure easily. f) A mechanical maintenance switch is built in the power battery pack. It can be observed by opening the cover when the mechanical

	maintenance switch is pulled out. g) The outline line of power battery pack is equipped with an additional mechanical disconnecting emergency switch, which is applicable for easily disconnecting the main power supply circuit in emergency circumstances. • Accessories: - • Suggested instruments for best practice: Digital Multimeter.

ANNEXURE

New Energy Electric Drive Transmission System

Sr.No.	Name of Items
1.	**New Energy Electric Drive Transmission System.** **Specifications: -** Learning Objects The training bench is designed to develop the mainstream new energy pure electric vehicle components, having the same function and control mode of the popular pure electric vehicles. This trainer truly presents the connection and control relationship among the core components of new energy pure electric drive system, the installation position and operating parameters and the safety precautions for high voltage system. It is developed to improve students' ability to analyze and process the failures of new energy pure electric drive system. **Main Characteristics:-** This truly operational new energy electric drive transmission system integration fully demonstrates the structure and logic control relationship of all main components. All components are installed on the bench, with the same electrical connection mode as real vehicles, convenient for assembly and disassembly. This makes students learn the disassembly points and safety protection of high voltage system components during disassembling and assembling connection. The connecting lines can be scanned with the help of a two-dimensional code, after which, their assembly and disassembly methods and precautions can be completely demonstrated on the screen.Real-time details display screen. **General Characteristics:-** • Dim. mm (HxLxW) : 1800x1600x1200 • Weight approx. 300 kg • Auxiliary battery: 12V 45AH. • Power battery type: Environment-friendly lithium iron phosphate power battery (square aluminum case, single battery 3.2V 50AH). • Capacity of power battery pack: 72V 50AH (3.7 kilowatt-hour). • Input power supply: AC 220V±10% 50 Hz. • Operating functioning temperature: -5℃ to +40℃. **Accessories: -** Suggested instruments for best practice: • Digital Multimeter. • Vehicle-mounted charger and charging plug • DC-DC (From 72v DC to 12v DC) converter • Electronic throttle assembly • Shift mechanism assembly • Driving motor / Motor controller • Gearbox / Driving shaft /Front wheel disc **Tension controller** • Booster pump assembly / Vacuum pump assembly /Vacuum tank assembly • Auxiliary battery / Battery Management System (BMS) • Emergency power switch. **Other Characteristics: -** a) Power battery pack display, and instruments are installed on the teaching board, where there is a circuit control chart. Pressing the accelerator, students can observe all the parameters about the running status of the vehicle and master the operation control logic of pure electric vehicle and the law of parametric variation of main components. With the help of smart switch, the control logic under each state can be reproduced on the screen. b) The training bench consists of a main bench and a teaching board. The bench is placed horizontally for installing main components. The teaching board is placed vertically and connected with screws. At the bottom of training bench, 4 wheels are installed for moving flexibly, which also has self-lock device for fixing position. Pivoting wheels are mounted. c) The power battery pack is designed to be translucent with built-in LED bank lights for

	lighting so that students can observe the internal structure of battery. d) With real mechanical gear transmission and brake system, students can observe the braking energy feedback current variation and master the concept of braking energy absorption. e) The training bench has an electric vacuum assisted hydraulic brake system and switch signals can be controlled intelligently through pressure sensor. f) The training bench is equipped with a 12V power ground mechanical switch which can disconnect the 12V ground from time to time so as to disconnect the power supply of the whole system. g) The training bench is equipped with brake shield and other safety protecting devices for a safe use of students. h) It is equipped with intelligent fault • setting and appraisal system.

ANNEXURE

Passive Safety Devices for Motorcars

Sr.No.	Name of Items
1.	**Passive Safety Devices for Motorcars** **Learning Objects:-** This simulation panel allows the testing and the troubleshooting on the devices developed with the purpose of increasing the safety of driver and passengers inside motorcars. General Characteristics: - • Dim. mm approx (HxLxW) : 700x1000x150 - (470 with the base) • Weight approx. kg 25 • Input power supply: AC 220V±10% 50 Hz • Working temperature: -40℃ ~ +50℃. **Main Characteristics: -** The simulator considers all those systems to allow the reduction of the consequences of accidents; in -bag (driver-bag, passenger-bag, side- - -off inertial -function valve in the fuel tank This vertical frame bench-top trainer is specially designed to show to students how automotive systems work. The simulator consists of a panel • operated by the support of a computer with a coloured silk-screen diagram that clearly shows the structure of the system and allows the location of the components on it. The display of the information available on the computer screen allows the continuous control of the educational system. The operational conditions can be entered by the students and the insertion of faults can be carried out through the computer by the teacher. The trainer is supplied with a CAI Software and the supported documentation guides the students to the study and the performance of the simulation exercises. All components installed and given leads are made to protect the safety of the students.

ANNEXURE

Antilock Braking Simulator

Sr.No.	Name of Items
1.	**Antilock Braking Simulator** **Specifications: -** Learning Objects:- This simulation panel has been specially designed and realized to allow for a complete and easy learning of the techniques and the electromechanical devices used in the anti lock braking systems in the cars. It is possible to simulate a braking system, provided with a four sensors anti-lock system (ABS). The panel shows how modern car ABS systems are designed to operate. General Characteristics • Dim. mm approx (HxLxW) : 700x1000x150 - (470 with the base) • Weight approx. kg 25 • Input power supply: AC 220V±10% 50 Hz • Working temperature: -40℃ ~ +50℃. Main Characteristics:- The system covers the following subjects: • ABS operation when wheels rotate at different speeds • ABS operation when wheels rotate at same speed • Pressure measurement during operation • Hydraulic ABS valve operation • Self-diagnosis control • Fault diagnosis procedure • Various control signals measurements in the ABS system • Low fluid level detection • ABS operation with one wheel speed sensor is disconnected • ABS operation with destroyed hydraulic valve • Brake system operation when the electronic brake unit is disconnected • Brakes operation when there is leakage • System operation with different relative rotation speed of wheels ABS operation with hydraulic valve stuck. This vertical frame bench-top trainer is specially designed to show to students how automotive systems work. The simulator consists of a panel operated by the support of a computer with a coloured silk-screen diagram that clearly shows the structure of the system and allows the location of the components on it. The trainer is supplied with a CAI Software and the supported documentation guides the students to the study and the performance of the simulation exercises.All components installed and given leads are made to protect the safety of the students.

ANNEXURE

Technical Specification for SCARA ROBOT, LEECH, MultiGripper Robot

Sr. no	Technical Specification	Qty
1	**SCARA Robot Features:** • High Precision and Accuracy • Lightweight Design • Strong Arm • Ultra-Fast • High rigidity independent shaft for prismatic joint • Precision Drive • Easy Programming • Vertical / Incline climbing: no **Specifications** • Axis Specification: o X- Axis: 225 MM o Y- Axis : 175 MM o Z- Axis : 100 MM o End effector Rotation : 360 degree • Accuracy: 0.5 MM • Number of Axis / Joints: 4 • Pay load: 1.2 Kg • Weight : 14 kg Operating Range - J1 – 250 Deg ++ J2 – 260 Deg ++ J3 – 160 Deg ++ J4 – 280 Deg++	1
	Features of Multi - Gripper Robot: **1. Easy Programming:** **2. Easy and Flexible deployment:** **3. Reliable Gear Drive:** The gear drive instead of the belt drive. **4. Servo Motors for precision and accuracy** • Power Consumption: 100 W (Approx.) • Payload: 500 grams • Degrees of Freedom: 4 • Maximum reach: 350 mm • Footprint: 300 mm • Weight: 6 Kgs • Enclosure Rating: IP54 • Repeatability: +/- 1 mm • Accuracy: +/- 1 mm • Cable Length: 3 m or 6 m • Outer Body Material: Nylon • Power Consumption: 100 W (Approx.)	1

	Rack and Pinion Gripper:- 1 • **Gripping Force:** 0.8 N • **Total Stroke:** 32 mm • **Force Sensing:** Current dependent • **Supply:** 5 V, 1A • **Control Signal:** PWM **Curvilinear jaw Robotic Gripper: -1** • **Gripping Force:**8 N • **Total Stroke:** 60 degrees (capable to pick diameter up to 80 mm) • **Force Sensing:** Current dependent • **Supply:** 5 V, 1A • **Control Signal:** PWM **Specifications of Cam Guided Gripper:-1** • **Gripping Force:** 0.8 to 1.2 N • **Total Stroke:** 24 mm • **Force Sensing:** Current dependent • **Supply:** 5 V, 1A • **Control Signal:** PWM	1
	Robotic Leech for Pipe Inspection and maintenance at various places. Minimum observable diameter of pipe: 75 mm Speed: 24 mm/s Total Weight: 104 g Enclosure: IP54 Power: Wired, 10W Control Input: PC Keyboard controlled Vertical/Incline Climbing: No Vendor Has to take care of Delivery & Installation	1

ANNEXURE

Technical Specification for Robotics and Automation for Electric Mobility

Sr. no.	Technical Specification	Qty
	1. <u>Technical Specification for Articulated Robotic ARM:</u> **Robotic arm for pick and place operations:** a. Number of Axes: 6; b. Pay load capacity: 2kg or more; c. Power supply: 230V AC, 50/60 Hz, 5A; d. Work envelope – 500 mm in 3600; e. Gripper equipped f. Above robot arm should be provided with all necessary cables, hardware, software and workstation. g. Enclosure Rating: IP54 • Repeatability: +/- 0.1 mm • Accuracy: +/- 0.1 mm • Cable Length: 3 m or 6 m • Outer Body Material: Nylon • Structural Chassis: Hybrid Aluminum and Steel	**<u>1</u>**
2	MAZE Robot equipped with Artificial Intelligence understanding of Track Path. The Atomized vehicle which runs on Arduino based can be further The vendor has to supply with Track, complete Platform The Provision of Vehicle for IOT need to be available.	**5**
3	**Li-ion Cell Test Bench & Demo for Testing & Aging** The Demo Setup Should consist 1. Rack frame for minimum, charge of Six Cell at a time 2. The Charging station should be equipped with back of One hour post power failure 3. The Lead cell for aging to be provided by vendor 4. The setup should be portable and need to carry for other locations.	**1**
4	**Electric Robotic Charger Setup** **Robotic Charger Setup** Charger capacity: 0.5 kW or more Type of robot: SCARA or Articulated type Degrees of freedom: 4 or more Automatic localizing and plugging	**1**

ANNEXURE

Technical Specification for Robotics Laboratory

Sr. No.	Description	QTY
1	**Innovation Lab Learning Equipment**	
	• Line Following Robot	**1**
	• Object Counter with Conveyor	**1**
	• Distance Measurement by Ultrasonic Sensor	**1**
	• Automatic Fan Switching - Integration of Sensor with Controller for Environmental Condition	**1**
	• Digital Dice	**1**
	• Object Counter	**1**
	• Two-wheel Balancing Robot / Self Balancing robot	**1**
2	• **Soldering Station**	**2**
	• Soldering Gun	
	• Hot Air Gun	
	• Soldering wire & flux	
	• Soldering stand	
	• Wire cutter & stripper	
3	• **Manufacturing Station for Robotics**	**1**
	• Vice – 2	
	• Bosch Power Tools	
	• C – Clamp	
	• Drilling Station	
4	• **Safety Equipment's**	**1**
	• Hand Gloves & Goggles,	
	• Anti-Static Wrist Strap	
	• Fire Extinguisher	
5	• **ECG Machine**	**1**
	• Light weight, small size and capable of simultaneous acquiring all 12 channels of ECG in Real time.	
	• Operates on commonly available rechargeable mobile battery.	
	• Can record ECG of multiple patients in single recharge.	
	• Lead Fail Alarm to indicate improper lead connection.	
	• No special mobile application required for viewing reports.	
6	• **Experienced Technical Resource for a Year**	**1**
	• For robotics Development & Training, covering all the Mechanical, Electronics & Software application.	
	• The training would be based on Build Operate Transfer.	
	• Key responsibility will be Robotics Innovation	

	• Publication on Research Paper and	
	• Robotics Product Patent Development.	
	• Theory & practical's	
7	Furniture and Fittings reguired for Robotic Lab with Poster & Flex for renovating the Lab	**1**
8	Training & Installation, Transpiration, Delivery	**1**

ANNEXURE

Technical Specifications Electric Power Train Test Bench

Sr. no	Technical Specifications	QTY
1	**Electric Power train Test bench & Demo Setup** **Battery** capacity: 3 kWh or more Voltage: 48 V Type: Li-ion BMS: With BMS **Motor** Power: 1 kW or more Type: BLDC Voltege: 48 V **Charger:** Capacity: 0.5 kW **Gearbox & Drivetrain:** Gearbox with wheel setup **Dynamometer:** Dynamometer with torque and rpm measurement setup Input power measurement setup **Charger standard demos** Types of chargers: 1) CHAdeMO 2) GB/T 3) COMBO Charger minimum rating: 0.5 kW **Electric Motor Testbench – 1(each)** 1) IPM Motor Testbench a. Power rating: 0.5 kW or more b. Driver/ Controller: With DC 48 V input Driver c. Dynamo: RPM and Torque measurement 2) BLDC Motor Testbench a. Power rating: 0.5 kW or more b. Driver/ Controller: With DC 48 V input Driver c. Dynamo: RPM and Torque measurement 3) Induction Motor Testbench a. Power rating: 0.5 kW or more b. Driver/ Controller: With DC 48 V input Driver c. Dynamo: RPM and Torque measurement	1

ANNEXURE
Technical Specifications Li-Ion Test Setup

Sr. No.	Technical Speciation	QTY
1	**Li-ion Cell Testing** Cell testing machine with various rates of charge and discharge **Li-ion Cell Testing/Inspection** Minimum number of cell capacity: 4 Rack Mounted Cells Systems with different sizes IR Sensor for position with accurate accuracy TriWires for complete Setup Power Supply 230 V AC Auto manual Switch. Types of Test: 1) Normal Charge 2) Normal Discharge 3) Overvoltage charging 4) Over current discharge Temperature monitoring Systems Inbuild Energy Meter Seven Segment Display Unit Indicators: Charge and discharge completion indicators Robust Body Construction	**1**
2	**Li-ion Cell Aging** Li-ion cell aging and lifecycle testing machine with various rates of charge and discharge, lifecycle testing **Li-ion Cell Aging** Minimum number of cell capacity: 4 Types of tests: 1) Load testing 2) Performance cycle testing 3) life-cycle testing 4) Cell Capacity measurement 5) The aging should be derived through Computer systems Post aging Emergency Switch, Individual on Off Switch Inbuild Voltmeter & Ammeter	**1**
3	Training & Installation, transportation, Delivery need to be provided by vendor	**1**

ANNEXURE

Technical Specification for IoT Laboratory

Sr No	Component name	Description
1	ESP WROOM 32 IOT module	Hybrid module with Wi-FI & Bluetooth. High level of integration. Ultra-low power management. 4 MB Flash. Current – Receiving: 80 mA. Supply Voltage: 2.2 V ~ 3.6 V. Data Rate: 54 Mbps. Frequency: 2.4 GHz.
2	Smart relay - wifi switch	Can use with AC-240Volts or DC voltages such as 12V / 24V / 48V, WiFi enabled
3	Multi-channel relay board	4-channel relay output modules, relay output contacts 250A 10A Input IN1, IN2, IN3, IN4, the signal line LOW effective VCC, GND power input, can relay a separate power supply relay power input of JD-VCC
4	Sensor kit with shield	
		Line Sensor
		Sound sensor
		Touch sensor
		Gas sensor
		Joystick potentiometer sensor
		Light sensor
		Magnetic switch
		Moisture sensor
		PIR miotion sensor
		Temperature sensor
		Humidity sensor
		Infrared sensor
		3 Axis Digital accelerometer & shield for arduino
		Turbidity sensor
		PpH sensor board
		Heart beat sensor
		Water flow sensor
		Water level sensor
		Current sensor
5	Arduino Uno	Arduino Uno is a microcontroller board based on the ATmega328P (datasheet)

		It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button
6	Particle Maker Kit	If you're new to the world of hardware, don't panic—the Maker Kit has everything you need to level up from hacker zero to hardware hero In addition to a shiny new Photon, the Particle Maker Kit includes all the components and accessories you need to start building simple Internet-enabled projects The Maker Kit comes with enough jumper wires, LEDs, resistors and more to make sure you can can build multiple different types of projects It also comes with a super-neat project carrying case so you can put tidy up your workspace when you're done building
7	Internet Button	The Internet Button includes a Photon, which can also be easily removed and used for other projects, a USB-micro cable and a removable plastic cover Quickly start playing with LEDs, multiple buttons, an accelerometer and more without any wires or soldering On the firmware side, custom libraries are available to make programming your projects quick and beautiful The Internet Button is not only an easy way to get started on the Internet of Things, it's also a clean and simple way to start building your own prototypes
8	DC Motors & shield kit	DC geared motor 100RPM - 2
		DC Motor shield - 1
		Chassis - 1
		Castor wheel - 1
		70mm tyres - 2
9	Servo motors & shield kit	DC servo motor - 2
		Servo motor shield - 1
10	GPS tracker Kit	The Asset Tracker Kit contains all of the hardware you need to build a GSM + GPS location tracker for your most prized possessions In addition to a GPS Shield and Electron, the Asset Tracker Kit comes with a weatherproof enclosure, so it'll keep your electronics safe from the dust, dirt, and moisture of the great outdoors
11	Battery section	12V 7000Ah lead acid battery
		5V 5000mAh power bank
12	Hardware essentials kit	Digital Multimeter - 1
		Bluetooth module - 2
		WiFi module - 2
		LED Bulbs + holder - 2,
		DC / AC fans - 1 each,
		Water pump 12v - 1,

		Solenoid valve - 1,
		12V 2A adaptor - 2
		Screw driver - 1
		Stripper - 1
		Soldering gun - 1
		LCD 16x2 - 1
		Max 7219 8x8 Dot matrix display - 1
14	Smoke Detector Kit	MQ2 Sensor, ESP8266, PCB module, Power supply
15	Home Automation Kit	Relay modules, PCB module, PiO, Power supply
16	Smart Locking Systems Kit	Bluetooth module, PCB module, Relay module, ICs, Electro-magnetic lock.
17	IoT Starter Kit	• Hardware kit comprising of analog and digital inputs • One waterproof temperature sensor • On-board ADC, Raspberry pi microcontroller • Software and OS preinstalled • Display • USB cable, Power supply adapter
18	Consumables kit	Solder metal (50gm)
		Nut & bolts set
		2 Pin AC plugs pair
		Wires - 20m
		General Purpose PCB
		Resistor pack
		Capacitor pack
		Connector pack
		LED pack
		IC pack
		Insulation Tape

ANNEXURE
Specification for Structural Analysis and Optimization Framework

Sr. No.	Description	
1.	The vendor should deliver: • Commercial Grade R&D License • 5-Users • Paid-Up License, M &S for 1 Year • 64-bit, Windows, Node Locked / Floating	
	The software package must provide the following tools:	
2.	Design Engineers Concept Design and Optimization Tool should have the following • Accurate auto mesh • Topology / Topography / Gauge / Lattice Optimization. • Polynurbs : Polygonal modelling capabilities - NURBS from polymesh data. • Motion Analysis for extracting forces in the mechanism for Optimization or FEA. • Manufacturing Feasibility at product design stage for Castability & Formability. • Design for additive manufacturing to create more self-supporting structures • Export lattice designs in a. stl file format for 3D printing • Assign loads to load cases and import / export design loads in .csv file • Manufacturing & Shape Controls Capability: single draw, split draw, extrusion, symmetry, cyclic symmetry constraints for Topology concept generation. Stamping feasibility to check the thinning distribution and potential formability issues cracks and wrinkles. • Direct modeling capability-Sketch tools like lines, Geometry tools-mirroring, scaling, revolving, push/pull, tangency and perpendicularity. Geometry export capability-IGES, PARASOLID, STEP, STL. • Add customized material to the library • Automatic mid surface generation • Partition tool to be available for dividing a part into design and non–design regions by selecting a hole, pocket, or face to offset. • Bead pattern visualization to know the bead boundaries • Perform FEA on optimized concept of sheet metal/solid components. • Contact Tools to find neighbouring parts and designate whether the type of contact to be bonded/contacting/ have no contact	

	• Fastener and Joints tools to add bolts, screws, pins, or sliding pins • Grounded bolts, grounded screws, grounded pins and grounded sliding pins that can act as supports in load cases • Joints tool to be available to identify and create hinge, cylindrical, translational, ball and socket, planar • *.FEM input file format should be generated for: • Topology & Topography • FE analysis • Capability to create final output files using polyNURBS- Ready for 3d printing/Manufacturing	
3	Meshless Structural and dynamic analysis solver should consist of the below features • No geometry simplification and meshing is required to solve structural and dynamic analysis • Meshless Structural And Dynamic Solver to analyse complex parts and assemblies • High Capacity – Large Assemblies, Complex Parts Multi-Pass Adaptive Process, Smart Functions Material Properties: Isotropic Material Incompressible Material Elastoplastic with NL stress vs strain curves Material Rigid Material User extensible Material • Linear statics, modal, thermal, coupled thermal-stress, material nonlinear, geometric nonlinear, transient dynamics • Connections – bonded, sliding, virtual connectors, welds (spot, laser and fillet) • Contour plots with displacements, stress & strains • Deformed shape animation • Max/min labels • Point probes • XY plots • Reaction/contact forces • Bolt/nut forces • Spot weld forces • Frequencies and mode shapes • Modal participation factors • Safety Factors	

	• CAD file formats including: CATIA, NX, PTC/Creo, Inventor, Fusion 360, SOLIDWORKS, SolidEdge, Onshape, JT, STEP, VDA, Parasolid, ACIS, PLMXML, CGR, STL	
4.	Finite Element Modelling Tool • Automated Mesh Generation • Tetra and hexa meshing of solids • Quad and tria meshing of surfaces • 1D mesh creation for joining parts and contact surfaces • Feature Based Meshing • Automatically identifies CAD features • Applies template criteria to mesh creation of features, such as cylinders, fillets or holes. • Automatic recognition of contact surfaces • Eliminates tedious CAD geometry clean-up and removes geometry translation errors • Uses templates and captured knowledge to generate accurate meshes per analysis type, such as Stress NVH, Acoustic, Fatigue • Simplified model and assembly modifications • Part replacement • Add or modify ribs within solid models • Change fillet/cylinder/hole properties • Local model morphing • Automated templates • Bolt modelling • Gasket, bearing loads, and joint modelling • Mass property idealization • External material and property based connections • Contact detection and modelling A finite element pre-processor with the broadest set of direct interfaces to commercial CAD and CAE systems. It should provide: • Access to a variety of mesh generation capabilities, For 2D and 3D model creation. • Automeshing module like High Fidelity Meshing, Surface Meshing, Solid Meshing, and Batch Meshing	

	• BatchMesher to automatically generate high-quality finite element meshes; provides user specified control over meshing criteria and geometry clean-up parameters as well as the ability to output to customized model file formats	
5.	Composite Design and Analysis Solver: • Composite solver materials database, with properties for 1000+ commercial material systems • Covers layered composite structures from preliminary design to analysis of details • Composite solver integration enhances composites pre- and post-processing. • Composite material data is readily available for (initial) design purposes • Composite solver allows evaluation and selection of materials by considering the materials as part of an actual composite structure • Composite solver lay-up design user environment to quickly create and modify lay-ups • Export function from Composite solver transfers the data reliably and effortlessly, without the risk of transcription errors • Gain insight on failure margins, critical layer and failure mode information all from within Post processing environment • Additional knowledge on the laminate behaviour Composite solver through-the-thickness plots	
	The license should provide a structural analysis tool developed specifically for rapidly evolving design processes. The following simulation types should be supported: Linear statics, modal, nonlinear statics (material & geometrical), thermal, coupled thermal-stress, linear dynamics (time, frequency and random response).	
6	The license provides a dedicated tool for multi-disciplinary design exploration tool used for parameter screening, optimization, reliability and stochastic studies. • The tool should automatically create intelligent design variants, manages runs, and collects data. • The tool must have Design of Experiments (DOE) methods: o Full factorial o Plackett-Burman o Central composite design o Modified Extensible Lattice Sequence (MELS)	

	○ Hammersley ○ D-Optimal ○ Fractional factorial ○ Box-Behnken The tool must provide following optimization methods to solve different types of design problems including multi-objective and reliability/robustness based design optimization. • Adaptive response surface method (ARSM) • Sequential quadratic programming • Genetic algorithm • System Reliability Optimization (SRO) • Sequential optimization and reliability analyses (SORA) • Single loop approach • Method of Feasible Directions (MFD) • Global response surface method (GRSM) • Multi-objective genetic algorithm • ARSM based SORA • User-defined optimizer	
7.	A finite element pre-processor with the broadest set of direct interfaces to commercial CAD and CAE systems. It should provide: • Access to a variety of mesh generation capabilities, For 2D and 3D model creation. • Automeshing module like High Fidelity Meshing, Surface Meshing, Solid Meshing, and Batch Meshing • BatchMesher to automatically generate high-quality finite element meshes; provides user specified control over meshing criteria and geometry clean-up parameters as well as the ability to output to customized model file formats.	
8	Explicit structural analysis tool for highly non-linear problems under dynamic loadings. It should provide: • Comprehensive material libraries. The material laws and failure models for concrete, foam, rubber, steel, composites, biomaterials, and more. • The solution types should include: ○ Nonlinear explicit dynamic structural analysis ○ Nonlinear implicit structural analysis ○ Euler, Lagrange and Arbitrary Euler-Lagrangian (ALE) formulations	

	○ Smoothed-Particle Hydrodynamics (SPH) ○ Finite Volume Method (FVM) based airbag simulation. ○ XFEM for crack propagation in multi-layer shells. ○ Advanced Mass Scaling for quasi-static problems, drop and impact tests, to increase the time step and by the way reduce the elapse time significantly without degradation of the accuracy. ○ Sub-Modeling for local design of components or sub-structures. ○ Hot-forming simulation capabilities	
9.	Structural analysis tool for linear and nonlinear problems under static and dynamic loadings. It should support and include: • A comprehensive range of physics for powertrain analysis. • Solutions for heat transfer, bolt and gasket modeling, hyper-elastic materials, and efficient contact algorithms. • Integrated Fast and Large-Scale Eigenvalue Solver with built-in feature of Automated Multi-level Sub-structuring Eigen Solver (AMSES) that can rapidly calculate thousands of modes with millions of degrees of freedom. • Advanced functionality for NVH analysis including one-step TPA (Transfer Path Analysis), Powerflow analysis, model reduction techniques (CMS and CDS super elements), design sensitivities, and an ERP (Equivalent Radiated Power) design criterion to optimize structures for NVH. It should provide following Analysis features: • Stiffness, Strength and Stability • Linear and nonlinear static analysis with contact and plasticity • Large displacement analysis with hyperelastic materials • Fast contact analysis • Buckling analysis • Noise and Vibrations • Normal modes analysis for real and complex eigenvalue analysis • Direct and modal frequency response analysis • Random response analysis • Response spectrum analysis • Direct and modal transient response analysis • Preloading using nonlinear results for buckling, frequency response, and transient analysis • Coupled fluid-structure (NVH) analysis • AMSES large scale eigenvalue solver	

	• Fast large scale modal solver (FASTFR) • One-step transfer path analysis (PFPATH) • Radiated sound analysis • Heat Transfer Analysis • Linear and nonlinear steady-state analysis • Linear transient analysis • Coupled thermo-mechanical analysis • One-step transient thermal stress analysis • Contact-based thermal analysis • Kinematics and Dynamics • Static, quasi-static, and dynamic analysis • Loads extraction and effort estimation • Optimization of system and flexible bodies Structural Optimization • Topology, topography, and free-size optimization • Topology optimization for 1D, 2D and 3d Elements: Manufacturing constraints like Minimum member size, maximum member size, Draw direction including split and single draw, Extrusion constraints including twist and no twist, Pattern grouping including 1 Plane symmetry, 2 plane symmetry, 3 plane symmetry, uniform, cyclic, cyclic 1 plane symmetry and Pattern repetitio • Topography optimization: Manufacturing constraints including bead width, bead height, bead angle, draw direction with normal to elements and direction as per global or user defined directions. Pattern grouping includes linear, circular, planar, radial 2d, cylindrical, radial2d+Linear, radial3d, 1plane symmetry, 2 plane symmetry, 3 plane symmetry, cyclic, cyclic-1 plane, cyclic linear, cyclic radial, cyclic linear + radial, Bounds, Pattern repetition. • Free-size optimization: Manufacturing constraints including minimum member off, minimum thickness off, maximum thickness off, Ply thickness, Ply Percentage, Ply manufacture, Ply balancing, Ply constant, Ply drop off, Pattern grouping including 1 Plane symmetry, 2 plane symmetry, 3 plane symmetry, cyclic, cyclic 1 plane symmetry, Pattern repetition. • Size optimization, discrete size optimization • Composite Size: Manufacturing constraints including minimum thickness off, maximum thickness off, Ply thickness, Ply Percentage, Ply manufacture, Ply balancing, Ply constant, Ply drop off	

	• Composite shuffle : Manufacturing constraints include Pairing constraints include same and reverse, successive plies, core number of plies, cover number of plies • Shape optimization : Manufacturing constraints include moving limit, Single, multiple and nonlinear design variables, discrete shape variables • Free-shape optimization : Manufacturing constraints include Unconstrained, Max grow blank and max shrink blank direction, smoothing method like optimized for speed, optimized for accuracy, number of smoothing layers, number of grids in transition zone, maximum moving vector, single draw direction, extrusion direction include global and user defined direction, 1 plane pattern grouping, grid con constraint type like fixed, vector and planar, side con constraint like manual and blocks and barrier mesh • Design and Optimization of Laminate Composites • Gauge optimization for shell and composites with discrete design variable • Design and Optimization of Additively Manufactured Lattice Structures: Manufacturing constraints include clean, porosity high, medium and low. Lattice types include, hexahedra, pyramid, tetrahedral, pentahedral. • Ply shapes (phase 1), optimal number of plies (phase 2) and the optimal ply stacking sequence (phase 3) • Equivalent static load method • Multi-model optimization	
10	Material Characterisation solver • Forward homogenization and inverse optimization technologies • Built-in parametric unit cells for unidirectional, woven, chopped, and particulate fiber composites • Parametric Built-In FEA Models • Advanced Continuum Damage • All Presented Material Characterisation solver Comparisons vs. Measured Data from NIAR NCAMP Reports • Void content, microcracks, interface/interphase properties • Forward homogenization and inverse optimization stochastic simulation • Probability distribution function for the homogenized macro-scale properties • Micro-scale geometry and constitutive properties	
11	Manufacturing Simulation <u>Sheet Metal Forming Simulation Tool</u>	

	• Stamping simulation software with the ability to do product design, feasibility analysis and cost estimation. • Ease of Use • Geometry based user interface with natural workflow left to right: o Import geometry o Prepare geometry o Assign material o Define stamping direction o Define constraints o Run analysis, visualize result o Blank fit and nesting • Geometry tools for product design and analysis o Sketching tool set o Solid modeler o Boolean tools o Geometry cleanup tools o Midsurface extraction o Feasibility check for regular and tailor welded parts o Feasibility check for single and double attached manufacturing scenarios. o Option to define arbitrary stamping direction. o Ability to capture detailed process conditions: pins, blank holder force, drawbeads. o Built in material database based on SAE standard with option for user database to manage own materials • Complete Nesting solution o Accurate blank shape prediction. o Option to add additional material to account for addendum. o Nesting for transfer die forming with blank fit option to standard shapes: rectangle, parallelogram, trapezoidal, miter, chevron and sweep. o Nesting with one-up, two-up and mirror layout for progressive die forming with standard carrier options: single, central, nested double-sided, double-sided and central and double-sided and nested. Casting Process Simulation Solver • Automatic mesh Generation in FE • One-click geometry generation of casting components • Geometry modelling capability to create entire shot model (gate, runner, mold, risers, chillers)	

	• Casting defects such as air entrapment, shrinkage porosity, cold shuts, mold degradation • Gravity, Die, High Pressure, Low Pressure, Investment and Tilt casting templates • Bi-phasic Finite Element formulation captures filling and solidification process	
12	Post Processing Tool • Complete visualization environment for FEA, CFD, and multi-body system simulation data. • A multi-window, multi-page environment: To check for correlations between two models or simulation and reality, results can be overlaid with a model or video within the same window. • Results Math is a powerful tool to generate new results from existing simulations by using mathematical expressions or external scripting languages. • Time consuming result manipulation tasks can be performed in batch file. • All post-processing sessions can be stored in a session file or a report template. • Session files help to reopen a complete session spanning across multiple pages and applications. • Tool enables users to share CAE results within a 3D web environment or Microsoft PowerPoint using compact file. • Users can create custom model views such as section cuts and exploded views by combining functionality from Tool's comprehensive post-processing tool and utility set • Different types of animations like Animations Contours (Scalar & Tensor), Vector plots, dynamics animations with flex-bodies are supported. • Tensor plots, Deformation plots, CFD streamline plots, Deformed animations, Linear animations, Modal animations, Transient animations, Multi-body • Tool saves 3-D animation results in compact format • Visualization environment for finite element analysis, CFD and multi-body system data • Data Analysis and Graphical Tool • Eliminates repetitive tasks. Plot macros capture and automate common math expressions.	
	Data Analysis and Graphical Tool	

	• Plot macros capture and automate common math expressions. • Report templates can capture and automate the building of entire pages of data plots. These can be reused for model variations and similar models. • A library of over 200 mathematical functions is included and user defined math functions can be added. • Tool supports units starting from data import all the way through predefined functions. Conversion between units is possible. • Automation tools for efficient data analysis and report generation • Contains a sophisticated math engine for performing complex mathematical operations or building custom math expressions	
13	The vendor or OEM should conduct Faculty Development Programs (3-days each) on the following domains: o Meshing, Pre-processing for Finite Element Analysis o Linear & Non-Linear Analysis o Concept Level Optimization o Structural Optimization o Meshless Analysis o Concept Design	
14	The vendor or OEM should provide a free Training Programs, for various domains of engineering. • The training programs should be conducted for total of 8 days in a calendar year. • Under this free training program, the vendor or OEM should have a dedicated website to register for such trainings. • The training classes should be at vendor/OEM's regional offices as well as university. • Some of the training that vendor/OEM should offer are: o Concept Design o Optimization o Structural Analysis	
15	The vendor/OEM should provide certification program for the students, to improve their knowledge and productivity. Students can take free certification through the online portal of the OEM of the software tool. The certification program should be on: • Pre-processing and meshing • Optimization Examinations	

	• Design Exploration, Study and Optimization	
16	The OEM/vendor should provide an online Learning Library to offer videos and resources that can be used to build the skills of the students.	
17	The vendor/OEM should provide the teaching material on the tools as mentioned below. • PPTs (for your presentations while teaching in the classroom) • Reading material (PDFs) for your students` self-learning • Tutorials - Handouts (PDFs) for your students • Model Files to practise	
18	The vendor/OEM should provide Internship Opportunity of eligible students; subject to their terms and conditions. The vendor/OEM should conduct tests and interviews of shortlisted students, once a year, to select students either for internship or as trainees. Subject to selection criteria. The selection should be based on eligibility and positions being available at OEM.	
19	The vendor/OEM should Conduct two Workshops in a year on emerging topics like: • Concept Design • Simulation Driven Design • Design for Manufacturing • Light Weighting • The cost and infrastructure for conducting workshop to be borne by the institute. The vendor/OEM should to provide expertise. • The vendor/OEM should arrange domain expert speakers for these workshops, from OEM & Industry, subject to availability. • The workshops should include latest updates & case studies in Simulation for Engineering domain covering varied topics like, Crash/Safety, CFD for improved product design, Design for 3D Print, Composites, Manufacturing Simulation, etc	
20	The OEM should provide access to an “online portal” for “Industry-Institute” collaboration, and accessible to institute, select students and to connect with registered companies on the portal. This portal should provide opportunity to connect with the participating companies on the program and attend events from Industry experts sharing their specialized knowledge.	

ANNEXURE
Specification for CFD and Thermal Management Application

Sr. No.	Description	
2.	The vendor should deliver: • Commercial Grade R&D License • 5-Users • Paid-Up License, M &S for 1 Year • 64-bit, Windows, Node Locked / Floating	
	The software package must provide the following tools:	
2.	A general-purpose finite element-based Computational Fluid Dynamics (CFD) flow solver. This tool should provide • Full set of physical models for flow, turbulence, immiscible and heat transfer simulations. • Solutions for both transient and steady-state simulations It should provide following capabilities: • Fully coupled pressure/velocity solver for all supported flow regimes • Fully coupled temperature/flow solver for highly buoyant flows • Heat Transfer and Radiation Modeling • The tool should support a full set of features for analysing heat transfer in both solid and fluid mediums. Supported features should include: • Conjugate heat transfer • Natural convection • Enclosure radiation • Solar radiation • Thermal shells for modeling thin solids • Simplified heat exchanger models Multiphysics Capabilities • Rigid body dynamics coupling • Practical Fluid/Structure Interaction (P-FSI) • Direct-Coupling Fluid/Structure Interaction (DC-FSI) • Direct-Coupled with Multi-body dynamics software MotionSolve Complete selection of turbulence modeling capabilities. Available RANS models should include: • Spalart-Allmaras	

	• SST • k-ω, BSL k-ω • Realizable k-ε, RNG k-ε, Standard k-ε For higher resolution transient simulations, the tool should support the following models: • Spalart-Allmaras based Detached Eddy • Simulation (DES and DDES) • SST based (DDES and Zonal DES) • Dynamic coefficient and fixed coefficient • Large Eddy Simulation models For simulations involving turbulent transition, the tool should supports the following transition • models (compatible with Spalart-Allmaras • and SST RANS/DES models): • γ one-equation model • γ-Reθ two-equation model External Aerodynamics : The Tool for this application should be capable of the below Pre-processing & geometry editing • No surface mesh requirement • Generate robust volume mesh from CAD. • Short model preparation time • Easy part replacement. • Case Setup models based on application user interface. Solver • Lattice Boltzmann based CFD solver. • Runs only on NVIDIA Tesla GPUs on Linux OS. • LES turbulence model and sophisticated wall modelling. • Moving Reference Frame. • Fan rotation using MRF • Rotating wheel modelling and five belt system Post-Processing & Data Visualisation • Post processing features on client server, parallel and batch scripting. • Job management system & remote visualisation. • Job monitoring and summary for aero. coefficients, voxels, runtime. • Supports sectional and accumulated drag. • Remote post processing feature • Comparison and detail analysis using various data visualization features.	

	Supports animations, iso-surfaces, sections, probes.	
3	Finite Element Modelling Tool • Automated Mesh Generation • Tetra and hexa meshing of solids • Quad and tria meshing of surfaces • 1D mesh creation for joining parts and contact surfaces • Feature Based Meshing • Automatically identifies CAD features • Applies template criteria to mesh creation of features, such as cylinders, fillets or holes. • Automatic recognition of contact surfaces • Eliminates tedious CAD geometry clean-up and removes geometry translation errors • Uses templates and captured knowledge to generate accurate meshes per analysis type, such as Stress NVH, Acoustic, Fatigue • Simplified model and assembly modifications • Part replacement • Add or modify ribs within solid models • Change fillet/cylinder/hole properties • Local model morphing • Automated templates • Bolt modelling • Gasket, bearing loads, and joint modelling • Mass property idealization • External material and property based connections • Contact detection and modelling A finite element pre-processor with the broadest set of direct interfaces to commercial CAD and CAE systems. It should provide: • Access to a variety of mesh generation capabilities, For 2D and 3D model creation. • Automeshing module like High Fidelity Meshing, Surface Meshing, Solid Meshing, and Batch Meshing • BatchMesher to automatically generate high-quality finite element meshes; provides user specified control over meshing criteria and geometry clean-up parameters as well as the ability to output to customized model file formats	

	The license provides a dedicated tool for multi-disciplinary design exploration tool used for parameter screening, optimization, reliability and stochastic studies.
	• The tool should automatically create intelligent design variants, manages runs, and collects data.
	• The tool must have Design of Experiments (DOE) methods:
	  ○ Full factorial
	  ○ Plackett-Burman
	  ○ Central composite design
	  ○ Modified Extensible Lattice Sequence (MELS)
	  ○ Hammersley
	  ○ D-Optimal
	  ○ Fractional factorial
	  ○ Box-Behnken
	The tool must provide following optimization methods to solve different types of design problems including multi-objective and reliability/robustness based design optimization.
	• Adaptive response surface method (ARSM)
	• Sequential quadratic programming
	• Genetic algorithm
	• System Reliability Optimization (SRO)
	• Sequential optimization and reliability analyses (SORA)
	• Single loop approach
	• Method of Feasible Directions (MFD)
	• Global response surface method (GRSM)
	• Multi-objective genetic algorithm
	• ARSM based SORA
	• User-defined optimizer	

4	Post Processing Tool • Complete visualization environment for FEA, CFD, and multi-body system simulation data. • A multi-window, multi-page environment: To check for correlations between two models or simulation and reality, results can be overlaid with a model or video within the same window. • Results Math is a powerful tool to generate new results from existing simulations by using mathematical expressions or external scripting languages. • Time consuming result manipulation tasks can be performed in batch file.	

	• All post-processing sessions can be stored in a session file or a report template. • Session files help to reopen a complete session spanning across multiple pages and applications. • Tool enables users to share CAE results within a 3D web environment or Microsoft PowerPoint using compact file. • Users can create custom model views such as section cuts and exploded views by combining functionality from Tool's comprehensive post-processing tool and utility set • Different types of animations like Animations Contours (Scalar & Tensor), Vector plots, dynamics animations with flex-bodies are supported. • Tensor plots, Deformation plots, CFD streamline plots, Deformed animations, Linear animations, Modal animations, Transient animations, Multi-body • Tool saves 3-D animation results in compact format • Visualization environment for finite element analysis, CFD and multi-body system data • Data Analysis and Graphical Tool • Eliminates repetitive tasks. Plot macros capture and automate common math expressions.	
	Data Analysis and Graphical Tool • Plot macros capture and automate common math expressions. • Report templates can capture and automate the building of entire pages of data plots. These can be reused for model variations and similar models. • A library of over 200 mathematical functions is included and user defined math functions can be added. • Tool supports units starting from data import all the way through predefined functions. Conversion between units is possible. • Automation tools for efficient data analysis and report generation • Contains a sophisticated math engine for performing complex mathematical operations or building custom math expressions	
5	The vendor or OEM should conduct Faculty Development Programs (3-days each) on the following domains: o Meshing, Pre-processing for Finite Element Analysis o CFD o External Aerodynamics	

	○ Battery Thermal Management	
6	The vendor or OEM should provide a free Training Programs, for various domains of engineering. • The training programs should be conducted for total of 8 days in a calendar year. • Under this free training program, the vendor or OEM should have a dedicated website to register for such trainings. • The training classes should be at vendor/OEM's regional offices as well as university. • Some of the training that vendor/OEM should offer are: ○ CFD ○ Thermal and Heat Transfer	
7	The vendor/OEM should provide certification program for the students, to improve their knowledge and productivity. Students can take free certification through the online portal of the OEM of the software tool. The certification program should be on: • Pre-processing and meshing • Design Exploration, Study and Optimization	
8	The OEM/vendor should provide an online Learning Library to offer videos and resources that can be used to build the skills of the students.	
9	The vendor/OEM should provide the teaching material on the tools as mentioned below. • PPTs (for your presentations while teaching in the classroom) • Reading material (PDFs) for your students` self-learning • Tutorials - Handouts (PDFs) for your students • Model Files to practise	
10	The vendor/OEM should provide Internship Opportunity of eligible students; subject to their terms and conditions. The vendor/OEM should conduct tests and interviews of shortlisted students, once a year, to select students either for internship or as trainees. Subject to selection criteria. The selection should be based on eligibility and positions being available at OEM.	

11	The vendor/OEM should Conduct two Workshops in a year on emerging topics like: • CFD and External Aerodynamics • Battery Thermal Management • The cost and infrastructure for conducting workshop to be borne by the institute. The vendor/OEM should to provide expertise. • The vendor/OEM should arrange domain expert speakers for these workshops, from OEM & Industry, subject to availability. • The workshops should include latest updates & case studies in Simulation for Engineering domain covering varied topics like, Crash/Safety, CFD for improved product design, Design for 3D Print, Composites, Manufacturing Simulation, etc	
12	The OEM should provide access to an “online portal” for “Industry-Institute” collaboration, and accessible to institute, select students and to connect with registered companies on the portal. This portal should provide opportunity to connect with the participating companies on the program and attend events from Industry experts sharing their specialized knowledge.	

ANNEXURE
Specification for Motor and Control System Design Framework

Sr. No.	Description	
3.	The vendor should deliver: • Commercial Grade R&D License • 5-Users • Paid-Up License, M &S for 1 Year • 64-bit, Windows, Node Locked / Floating	
	The software package must provide the following tools:	
2.	A tool for Math, Scripting, Data Analysis & Visualization • Should provide an environment for doing calculations, manipulating and visualizing data (including from CAE simulations or test results), programming and debugging scripts useful for repeated computations and process automation. • Capable to perform a wide variety of math & linear algebra (including matrix analysis and differential equations), filter signals, fit polynomials through data, approximate or check results from commercial simulation software, perform optimization. • Single product with an Integrated Development Environment (IDE). • It should be based on the Open Matrix Language (OML), and also compatible with Octave and Python. It should have Built-in CAE Data Readers to import, visualize, and manipulate input & output data for CAE tools such as FEA, CFD, etc.	
3	The license provides a dedicated tool for Multi-Disciplinary System Simulation. • High level, Matrix-based Numerical Computing language as well as an interactive and unified programming environment for all types of math. • Multi - programming language (Open matrix language, Python 3.4 & TCL/TK) • Extensive 2D & 3D graphing, plotting enabled • Build in Debugger which speeds development. • Data Readers for CAE (Computer Aided Engineering) Pre-& post processing of data, Custom Applications and GUI to create user interfaces and interactive dialogs. • TCL/TK OML bridge to import/export data • Python bridge which helps import Python programs and scripts.	

	▪ Extensive functional libraries for Controls Systems, Signal Processing, Optimization, Statistics libraries, Python bridge, CAE Data Reader available within the product ▪ Model based development of hybrid systems, modelling and simulation of the continuous and discrete dynamical systems & optimization. ▪ Construct hierarchical, parameterized multi-disciplinary models ▪ Mix Signal-based and Physical (Modelica) components in the same diagram • Support for Modelica libraries like Mechanical, Electrical, Thermal within the same product. Allows the behavior of the real-world systems with the support for multiple domains like Mechanical and Electrical. • Easily extensible, built-in block libraries including library management • Model exchange or Co-Simulation through the Functional Mock-Up interface (FMI/FMU) with connectivity to multiple softwares • Co-simulation with multi-body dynamics with control systems • Co-simulation with Electromagnetic devices with control systems to perform system simulation. • Support for Spice Simulation • Compile models into executable code • Integration with Open Matrix Language (OML). • When modelling large or the complex systems the multiple blocks in the model can be converted in to the single block using the option called Super Block. Masking of the super block is possible. • If the library is not available, End users can also create a custom block with the C/OML/Modelica or Math script and can add to the existing library file. • Simulator provides users with several high performance numerical solvers that accurately and robustly solve dynamic systems including the Continuous, Discrete time and the Event based behaviours. • Model supports with the fixed step size and the variable step size of the function. Leverage the full power of rapidly growing Modelica community • Mechanical & electrical; fluids & structures; electromagnetic and thermal effects • Script based Optimization is a powerful mechanism for solving the general optimization problems and constrains. Example models for Hybrid vehicle simulation, motor controls of various types of motors, quarter car/half car suspension, CAE data processing etc.	

	The license should include tool for developing embedded systems, by automatically generating code from block diagram models and transferring to popular controller hardware. The tool should: • Generate efficient and compact ANSI C code for dynamic systems involving scaled, fixed-point operations. Tune parameters and monitor real-time data. • Simulate dynamic systems including continuous or discrete-time behaviours as well as event-based behaviours. • Automatically converts your block diagrams and state diagrams to microcontroller unit (MCU) hardware-ready code. • Interactive Hardware-in-the-Loop (HIL) Testing; capability to run plant model on the host computer while the control algorithm runs in real-time on the target MCU, communicating via a Hotlink. • Support for Popular Target MCU Hardware; including many industrial-strength devices from Texas Instruments (TI) as well as popular Arduino and Raspberry Pi devices. • JTAG hotlink for MCU-in-the-loop verification • Automatically generate code directly from system diagram • Support rapid prototyping and code generation for Texas Instruments MSP430, C2000 Delfino and Piccolo family, Cortex M3, MCUs, DSPs, and DSCs • Visual Real-Time Operating System • Full On-chip Peripheral Support ADC, PWM, GPIO, CAN, SPI, SCI (RS232, UART), I2C • Self-Documenting block diagrams make intellectual property easier to reuse • DLL wizard for Custom Block creation using C, C++, Fortran, or Pascal • Real-Time Data Monitoring and Acquisition, Exchange data with PCAN USB CAN device • Model discrete behavior using finite state-transition system Create, edit, and simulate state charts, Trigger state actions and transitions Integrated debugger with logging and breakpoints • Example libraries for motor control, multiple microcontrollers addressing automotive and other similar domains with C Code generation capabilities for each example model	

4	The license should include tool for developing embedded systems, by automatically generating code from block diagram models and transferring to popular controller hardware. The tool should: • Generate efficient and compact ANSI C code for dynamic systems involving scaled, fixed-point operations. Tune parameters and monitor real-time data. • Simulate dynamic systems including continuous or discrete-time behaviours as well as event-based behaviours. • Automatically converts your block diagrams and state diagrams to microcontroller unit (MCU) hardware-ready code. • Interactive Hardware-in-the-Loop (HIL) Testing; capability to run plant model on the host computer while the control algorithm runs in real-time on the target MCU, communicating via a Hotlink. • Support for Popular Target MCU Hardware; including many industrial-strength devices from Texas Instruments (TI) as well as popular Arduino and Raspberry Pi devices. • JTAG hotlink for MCU-in-the-loop verification • Automatically generate code directly from system diagram • Support rapid prototyping and code generation for Texas Instruments MSP430, C2000 Delfino and Piccolo family, Cortex M3, MCUs, DSPs, and DSCs • Visual Real-Time Operating System • Full On-chip Peripheral Support ADC, PWM, GPIO, CAN, SPI, SCI (RS232, UART), I2C • Self-Documenting block diagrams make intellectual property easier to reuse • DLL wizard for Custom Block creation using C, C++, Fortran, or Pascal • Real-Time Data Monitoring and Acquisition, Exchange data with PCAN USB CAN device • Model discrete behavior using finite state-transition system Create, edit, and simulate state charts, Trigger state actions and transitions Integrated debugger with logging and breakpoints • Example libraries for motor control, multiple microcontrollers addressing automotive and other similar domains with C Code generation capabilities for each example model	

5	The license should include tool for developing embedded systems, by automatically generating code from block diagram models and transferring to popular controller hardware. The tool should: • Generate efficient and compact ANSI C code for dynamic systems involving scaled, fixed-point operations. Tune parameters and monitor real-time data. • Simulate dynamic systems including continuous or discrete-time behaviours as well as event-based behaviours. • Automatically converts your block diagrams and state diagrams to microcontroller unit (MCU) hardware-ready code. • Interactive Hardware-in-the-Loop (HIL) Testing; capability to run plant model on the host computer while the control algorithm runs in real-time on the target MCU, communicating via a Hotlink. • Support for Popular Target MCU Hardware; including many industrial-strength devices from Texas Instruments (TI) as well as popular Arduino and Raspberry Pi devices. • JTAG hotlink for MCU-in-the-loop verification • Automatically generate code directly from system diagram • Support rapid prototyping and code generation for Texas Instruments MSP430, C2000 Delfino and Piccolo family, Cortex M3, MCUs, DSPs, and DSCs • Visual Real-Time Operating System • Full On-chip Peripheral Support ADC, PWM, GPIO, CAN, SPI, SCI (RS232, UART), I2C • Self-Documenting block diagrams make intellectual property easier to reuse • DLL wizard for Custom Block creation using C, C++, Fortran, or Pascal • Real-Time Data Monitoring and Acquisition, Exchange data with PCAN USB CAN device • Model discrete behavior using finite state-transition system Create, edit, and simulate state charts, Trigger state actions and transitions Integrated debugger with logging and breakpoints • Example libraries for motor control, multiple microcontrollers addressing automotive and other similar domains with C Code generation capabilities for each example model	
6	Low Frequency Electromagnetic Tool	

	A solver to for low-frequency electromagnetic and thermal phenomena for electrical engineering concepts. It should include: • 2D, SKEW and 3D Finite Element package for motor design, for a finer motor analysis • Efficient Machine Pre-Design tool • 2D and 3D Motor overlay template driven dedicated environment providing libraries of components (rotor types, slots shapes, windings) and predefined meshing options to quickly generate machine FE model • Embedded multi-parametric analysis capabilities dealing with different simulation domains and well suited for Multiphysics couplings. • Parametric solver allowing geometrical or physical parameter sweeps The tool with full range of physical models to simulate the low frequency behaviour of electromagnetic devices: • Magnetic: o Static, steady state AC magnetic, transient o Circuit and mechanical couplings • Electric: Electrostatic, conduction • Thermic: Steady state AC thermal, transient • Thermal couplings: Electrothermal, magnetothermal • Skewed geometries • The skew environment should have magneto static, steady state AC magnetic and transient magnetic capabilities. Coupling with system simulation tools for drive and control analysis to study control strategy. • Coupling with CFD tools, to study the flow and determine thermal hotspots during the operation of the machine • Auto-adaptive mesh refinement during solving in 2D & 3D • Demagnetization of permanent magnets The tool should have: • Complete workflow in a single user interface with 2D, 3D and skew, 2.5 D • Non-meshed coils • Design environment to build a machine from standard or customized parts, add windings and materials to run a selection of tests and compare results. • Capability to model both star and delta connected motors Support for non- meshed coils which allows to create complex coils, like circular coils, rectangular coils, composed coils, multi saddle coils, and saddle coils.	

	Feature extended multiparametric analysis capabilities, electrical circuit and kinematic couplings, the tool allows to analyze, design and optimize the following in single package. • Rotating machines • Linear actuators, solenoids • Transformers & inductances • Induction heating processes • Sensors • Cables, electric connections • Electromagnetic compatibility Wireless chargers for EV's	
	The tool should have in-built overlays • It should provide in-built motor overlays such as BLDC, PMSM, and Induction Motor in 3D. • It should provide in-built 2D overlays for BLDC Inner & Outer Rotor, PMDC, SRM, induction motor, induction motor outer rotor. • The overlays should consist geometry, mesh and windings It should provide in-built overlay for 3-phase transformer to perform no-load and short circuit test.	
	The solver features: • The modelling of machines should have a rotor or stator with Skew slots • Non- meshed coils which allows to create complex coils, like circular coils, rectangular coils, composed coils, multi saddle coils, and saddle coils. Mathematical model to consider thickness of lamination of both stator and rotor core.	
	The tool should provide the following productivity features: • Jiles Atherton model to calculate hysteresis losses • Provision for hysteresis modeling, based on Preisach's model, for accurate evaluation of iron losses and remanence effects • Preisach static vector model should be in available in 2D and 3D • Efficiency maps • The tool should provide dedicated macros for automated operations for: o PMSM efficiency maps o Finding out efficiency map max speed/ max torque point o Finding out efficiency map corner point, Imax, and angle o Halbach Magnetization For 2D and 3D o Creating initial non-meshed coils for radial motor	

	○ Compute frozen permeability. ○ Slipping mean value ○ Slipping RMS value Faulhabercoils	
	Thermal Analysis capabilities: The tool should provide steady state thermal and transient thermal application in 2D and 3D framework. • Thermal coupling in 2D environment • Steady state AC magnetic coupled with transient thermal • Steady state AC electric coupled with transient thermal • Electric conduction coupled with transient thermal • Thermal coupling application in 3D environment Steady state AC magnetic coupled with transient thermal	
	Specialized features: • The tool should be able to model both star and delta connected motors • The tool should be able to simulate streamer criterion, to evaluate breakdown voltage in order to improve the design of electrical equipment's • The tool should provide macro to drive motor with PWM signal • The tool should be able to drive through groovy language; User subroutines for hysteresis's current control. The tool should allow both T-phi and AV formulation	
	The tool should provide a dedicated module for the pre-design of electric rotating machines. • Design environment to build a machine from standard or customized parts, add windings and materials to run a selection of tests and compare results. • Effective machine parts management (slots, magnet shapes, etc.) with possible customizations. • Automated tests ready to be performed: • Maps vs (Id, Iq): Flux, inductance, torque, iron losses, etc • Open circuit tests with cogging torque and back-emf • Torque-speed curves & efficiency maps considering thermal, mechanics, electronics constraints. • Should allow to describe duty cycle for Efficiency maps computation • Should allow to do FE based tests at predesign stage. • Should couple with optimization tool to perform optimization at predesign stage.	

	• Automatically export results with design data as document	
7	Post Processing Tool • Complete visualization environment for FEA, CFD, and multi-body system simulation data. • A multi-window, multi-page environment: To check for correlations between two models or simulation and reality, results can be overlaid with a model or video within the same window. • Results Math is a powerful tool to generate new results from existing simulations by using mathematical expressions or external scripting languages. • Time consuming result manipulation tasks can be performed in batch file. • All post-processing sessions can be stored in a session file or a report template. • Session files help to reopen a complete session spanning across multiple pages and applications. • Tool enables users to share CAE results within a 3D web environment or Microsoft PowerPoint using compact file. • Users can create custom model views such as section cuts and exploded views by combining functionality from Tool's comprehensive post-processing tool and utility set • Different types of animations like Animations Contours (Scalar & Tensor), Vector plots, dynamics animations with flex-bodies are supported. • Tensor plots, Deformation plots, CFD streamline plots, Deformed animations, Linear animations, Modal animations, Transient animations, Multi-body • Tool saves 3-D animation results in compact format • Visualization environment for finite element analysis, CFD and multi-body system data • Data Analysis and Graphical Tool • Eliminates repetitive tasks. Plot macros capture and automate common math expressions.	
	Data Analysis and Graphical Tool • Plot macros capture and automate common math expressions. • Report templates can capture and automate the building of entire pages of data plots. These can be reused for model variations and similar models. • A library of over 200 mathematical functions is included and user defined math functions can be added.	

	• Tool supports units starting from data import all the way through predefined functions. Conversion between units is possible. • Automation tools for efficient data analysis and report generation • Contains a sophisticated math engine for performing complex mathematical operations or building custom math expressions	
8	The vendor or OEM should conduct Faculty Development Programs (3-days each) on the following domains: o Electrical & Electromagnetics o Motor Design & Analysis o Mechatronics o Math & Systems	
9	The vendor or OEM should provide a free Training Programs, for various domains of engineering. • The training programs should be conducted for total of 8 days in a calendar year. • Under this free training program, the vendor or OEM should have a dedicated website to register for such trainings. • The training classes should be at vendor/OEM's regional offices as well as university. • Some of the training that vendor/OEM should offer are: o Motor Design o Low Frequency Electromagnetic Simulation	
10	The vendor/OEM should provide certification program for the students, to improve their knowledge and productivity. Students can take free certification through the online portal of the OEM of the software tool. The certification program should be on: • Pre-processing and meshing • Electromagnetic Simulation	
11	The OEM/vendor should provide an online Learning Library to offer videos and resources that can be used to build the skills of the students.	

12	The vendor/OEM should provide the teaching material on the tools as mentioned below. • PPTs (for your presentations while teaching in the classroom) • Reading material (PDFs) for your students` self-learning • Tutorials - Handouts (PDFs) for your students • Model Files to practise	
13	The vendor/OEM should provide Internship Opportunity of eligible students; subject to their terms and conditions. The vendor/OEM should conduct tests and interviews of shortlisted students, once a year, to select students either for internship or as trainees. Subject to selection criteria. The selection should be based on eligibility and positions being available at OEM.	
14	The vendor/OEM should Conduct two Workshops in a year on emerging topics like: • Low Frequency Electromagnetic Simulation • Motor Design and Simulation • The cost and infrastructure for conducting workshop to be borne by the institute. The vendor/OEM should to provide expertise. • The vendor/OEM should arrange domain expert speakers for these workshops, from OEM & Industry, subject to availability. • The workshops should include latest updates & case studies in Simulation for Engineering domain covering varied topics like, Crash/Safety, CFD for improved product design, Design for 3D Print, Composites, Manufacturing Simulation, etc	
15	The OEM should provide access to an “online portal” for “Industry-Institute” collaboration, and accessible to institute, select students and to connect with registered companies on the portal. This portal should provide opportunity to connect with the participating companies on the program and attend events from Industry experts sharing their specialized knowledge.	

ANNEXURE
Specification for Antenna Design and High Frequency EM Simulation Interface

Sr. No.	Description	
4.	The vendor should deliver: • Commercial Grade R&D License • 5-Users • Paid-Up License, M &S for 1 Year • 64-bit, Windows, Node Locked / Floating	
	The software package must provide the following tools:	
2.	High Frequency Electromagnetic Tool An electromagnetic-EM simulation software that uses multiple frequency and time domain techniques with true hybridization for antenna design and placement, scattering, and EM compatibility (EMC), including EM pulses, lightning effects, high intensity radiated fields and radiation hazard. The tool should provide: • Method of moments (MoM) - Ideal for radiation and coupling analysis. • Multi-level fast multipole method (MLFMM) - Ideal for electrically large, full wave analysis. • Finite element method (FEM) - Ideal for problems with several dielectrics and waveguides. • Finite difference time domain (FDTD) - Well suited to modelling inhomogeneous materials and simulations over a wide frequency range. • Physical optics (PO) and large element physical optics (LE-PO) - Ideal for electrically very large radiation and scattering analysis. • Ray Launching geometrical optics (RL-GO) - Ideal for dielectric or metal, electrically very large scattering analysis. • Uniform theory of diffraction (UTD) - Ideal for electrically extremely large, perfect electrically conducting (PEC) structures. • Unique characteristic mode analysis (CMA) solver calculates modal currents, eigenvalues, modal significance and characteristic angles • Dedicated solver WinProp for wave propagation and radio network coverage analysis The tool should provide following full bi-directional hybridization: • Hybrid FEM-MoM solver / Hybrid FEM-MLFMM solver / Hybrid MoM-GO solver / Hybrid MoM-UTD solver / Hybrid MoM-PO solver / Hybrid MoM-LE-PO solver / Hybrid MLFMM – RLGO solver	

	The tool must have following Productivity Features: • In-Built Windscreen Antenna Analysis tool efficient analysis of antennas integrated into layered windscreens • Higher order and curvilinear element support that allows geometry to be meshed with larger triangles, which reduces the number of unknowns to be solved and the required memory. • Periodic boundary conditions for analysing repetitive linear and planar structures, for example frequency selective surfaces (FSS). • Fast array analysis for solving large, finite metallic antenna arrays. • Characteristic mode analysis that provides physical insight into the radiating behaviour of objects, allowing for a systematic approach to antenna design and placement. • Error estimation and adaptive meshing for assessing the quality of a mesh and adaptively refining the mesh in insufficiently meshed regions. • Model decomposition through the substitution of complex sources and receivers with numerically efficient equivalent sources. • Numerical Green's function for problems containing static and dynamic parts, allowing re-use of the static part of the solution in subsequent simulations • Adaptive cross approximation (ACA) acceleration of the method of moments solution of complex problems, also effective for low frequency problems. • Parallel and graphics processing unit (GPU) support for speeding up simulations.	
3	The tool must provide a dedicated module for wave propagation and radio network planning.	
	This module should provide wave propagation models for different scenarios and network planning simulators for various air interfaces. This tool should define/edit the settings of the simulation project: • Selection of the scenario (rural, urban, indoor, tunnel, etc.) • Selection of the required (pixel and/or vector) databases and the parameters of the databases can be modified (e.g. clutter losses, clutter heights, material properties, etc.) • Definition of simulation areas: Prediction areas (incl. multiple heights), resolution of the results matrices, size and orientation of the (arbitrary) prediction planes, etc. • Definition of the properties of the air interface • The properties of the mobile stations are defined (only relevant if network planning modules are used) • Sites, transmitters, and antennas are set and their properties	

	• (Tx power, carriers, antennas (location, radiation pattern, tilt,azymuth), cable losses..) are defined • All parameters of the propagation model can be edited The tool must provide a result browser and 3D result view, as follows: • Display of result maps (matrices) in 2D and 3D • Mouse tools to zoom, edit, rotate, ... • Display of propagation paths in 2D and 3D • Display of directional channel impulse responses for all pixels in the simulation area • Statistical evaluations of result maps (histograms, pdf, cdf, ...) • Masks and filters to analyze and/or manipulate specific areas • Evaluation along user-defined routes in result maps (virtual measurement routes) • Differences between predictions and measurements (incl. difference plots and statistical values) • Display settings to control the visualization (legend, thresholds, colors, symbols, text outputs on maps, etc.) • Additional layers with graphical elements drawn by the user can be displayed together with the simulation result maps Export of result maps to other data formats (e.g. Google Earth) and export along polygons into ASCII files	
4	The tool should provide a dedicate module that can be used to define the movement of the objects in the time variant scenarios. • Time variant behaviour can be assigned individually to each element in the vector database or to groups of objects. • For the time-variant scenarios all propagation models of the indoor scenarios should be used. Besides the indoor propagation models; a ray-optical model must be available to predict additionally the Doppler shift for each propagation path.	
5	This module should be able to compute: • Computed propagation paths in a car-to-car scenario. • Computed propagation paths in an adaptive cruise control (ACC) scenario. Spatial channel impulse response (CIR)	
6	Post Processing Tool	

	• Complete visualization environment for FEA, CFD, and multi-body system simulation data. • A multi-window, multi-page environment: To check for correlations between two models or simulation and reality, results can be overlaid with a model or video within the same window. • Results Math is a powerful tool to generate new results from existing simulations by using mathematical expressions or external scripting languages. • Time consuming result manipulation tasks can be performed in batch file. • All post-processing sessions can be stored in a session file or a report template. • Session files help to reopen a complete session spanning across multiple pages and applications. • Tool enables users to share CAE results within a 3D web environment or Microsoft PowerPoint using compact file. • Users can create custom model views such as section cuts and exploded views by combining functionality from Tool's comprehensive post-processing tool and utility set • Different types of animations like Animations Contours (Scalar & Tensor), Vector plots, dynamics animations with flex-bodies are supported. • Tensor plots, Deformation plots, CFD streamline plots, Deformed animations, Linear animations, Modal animations, Transient animations, Multi-body • Tool saves 3-D animation results in compact format • Visualization environment for finite element analysis, CFD and multi-body system data • Data Analysis and Graphical Tool • Eliminates repetitive tasks. Plot macros capture and automate common math expressions.	
	Data Analysis and Graphical Tool • Plot macros capture and automate common math expressions. • Report templates can capture and automate the building of entire pages of data plots. These can be reused for model variations and similar models. • A library of over 200 mathematical functions is included and user defined math functions can be added. • Tool supports units starting from data import all the way through predefined functions. Conversion between units is possible.	

	• Automation tools for efficient data analysis and report generation • Contains a sophisticated math engine for performing complex mathematical operations or building custom math expressions	
7	The vendor or OEM should conduct Faculty Development Programs (3-days each) on the following domains: o Antenna Designs o EMI / EMC o Wave Propagation Analysis	
8	The vendor or OEM should provide a free Training Programs, for various domains of engineering. • The training programs should be conducted for total of 8 days in a calendar year. • Under this free training program, the vendor or OEM should have a dedicated website to register for such trainings. • The training classes should be at vendor/OEM's regional offices as well as university. • Some of the training that vendor/OEM should offer are: o Antenna Designs and Electromagnetics o Wave Propagation Techniques	
9	The vendor/OEM should provide certification program for the students, to improve their knowledge and productivity. Students can take free certification through the online portal of the OEM of the software tool. The certification program should be on: • Pre-processing and meshing • Electromagnetic Simulation	
10	The OEM/vendor should provide an online Learning Library to offer videos and resources that can be used to build the skills of the students.	
11	The vendor/OEM should provide the teaching material on the tools as mentioned below. • PPTs (for your presentations while teaching in the classroom) • Reading material (PDFs) for your students` self-learning • Tutorials - Handouts (PDFs) for your students • Model Files to practise	

12	The vendor/OEM should provide Internship Opportunity of eligible students; subject to their terms and conditions. The vendor/OEM should conduct tests and interviews of shortlisted students, once a year, to select students either for internship or as trainees. Subject to selection criteria. The selection should be based on eligibility and positions being available at OEM.	
13	The vendor/OEM should Conduct two Workshops in a year on emerging topics like: • Low Frequency Electromagnetic Simulation • Motor Design and Simulation • The cost and infrastructure for conducting workshop to be borne by the institute. The vendor/OEM should to provide expertise. • The vendor/OEM should arrange domain expert speakers for these workshops, from OEM & Industry, subject to availability. • The workshops should include latest updates & case studies in Simulation for Engineering domain covering varied topics like, Crash/Safety, CFD for improved product design, Design for 3D Print, Composites, Manufacturing Simulation, etc	
14	The OEM should provide access to an “online portal” for “Industry-Institute” collaboration, and accessible to institute, select students and to connect with registered companies on the portal. This portal should provide opportunity to connect with the participating companies on the program and attend events from Industry experts sharing their specialized knowledge.	

ANNEXURE
Specification for Vehicle Dynamics and Suspension Analysis Framework

Sr. No.	Description	
5.	The vendor should deliver: • Commercial Grade R&D License • 5-Users • Paid-Up License, M &S for 1 Year • 64-bit, Windows, Node Locked / Floating	
	The software package must provide the following tools:	
2	The license provides a dedicated tool for multi-disciplinary design exploration tool used for parameter screening, optimization, reliability and stochastic studies. • The tool should automatically create intelligent design variants, manages runs, and collects data. • The tool must have Design of Experiments (DOE) methods: o Full factorial o Plackett-Burman o Central composite design o Modified Extensible Lattice Sequence (MELS) o Hammersley o D-Optimal o Fractional factorial o Box-Behnken The tool must provide following optimization methods to solve different types of design problems including multi-objective and reliability/robustness based design optimization. • Adaptive response surface method (ARSM) • Sequential quadratic programming • Genetic algorithm • System Reliability Optimization (SRO) • Sequential optimization and reliability analyses (SORA) • Single loop approach • Method of Feasible Directions (MFD) • Global response surface method (GRSM) • Multi-objective genetic algorithm • ARSM based SORA • User-defined optimizer	

3	A multi-body systems analysis module for mechanical system simulation. This tool should provide capabilities for multi-disciplinary simulations for system level analyses such as • kinematics and dynamics, • statics and quasi-statics, • linear and vibration studies, • effort estimation, • vehicle dynamics, • low frequency NVH • packaging synthesis. It should compute the necessary inputs for performing component strength calculations, weight minimization and fatigue life prediction. The tool should provide following simulation and analysis: • Assemble a system to satisfy all its constraints • Kinematic and inverse kinematic analysis • Static Equilibrium • Quasi-static and steady state solutions • Nonlinear, time domain dynamics simulations • Eigenvalue and Eigenvector calculation • Transfer function analysis given inputs and outputs • Scripted simulations; commands to modify the model • General purpose co-simulation	
4	A Generative Design/Topology Optimization and rapid simulation tool. • The tool should generate dynamic motion of complex mechanisms, automatically identifying contacts, joints, springs and dampers. • Forces obtained from a motion analysis should be automatically applied as inputs to a structural analysis and optimization, or could be used to determine initial requirements for motors and actuators. • Should offer a number of topology options including: optimization objectives, stress and displacement constraints, acceleration, gravity, and temperature loading conditions • Investigate linear static and normal modes analysis on a model and visualize displacement, factor of safety, percent of yield, tension and compression, von Mises stress, and major principal stress. The tool should be packaged with a material library including various aluminum, steel, magnesium, and titanium alloys. Custom materials could also be added.	
5	Post Processing Tool	

	• Complete visualization environment for FEA, CFD, and multi-body system simulation data. • A multi-window, multi-page environment: To check for correlations between two models or simulation and reality, results can be overlaid with a model or video within the same window. • Results Math is a powerful tool to generate new results from existing simulations by using mathematical expressions or external scripting languages. • Time consuming result manipulation tasks can be performed in batch file. • All post-processing sessions can be stored in a session file or a report template. • Session files help to reopen a complete session spanning across multiple pages and applications. • Tool enables users to share CAE results within a 3D web environment or Microsoft PowerPoint using compact file. • Users can create custom model views such as section cuts and exploded views by combining functionality from Tool's comprehensive post-processing tool and utility set • Different types of animations like Animations Contours (Scalar & Tensor), Vector plots, dynamics animations with flex-bodies are supported. • Tensor plots, Deformation plots, CFD streamline plots, Deformed animations, Linear animations, Modal animations, Transient animations, Multi-body • Tool saves 3-D animation results in compact format • Visualization environment for finite element analysis, CFD and multi-body system data • Data Analysis and Graphical Tool • Eliminates repetitive tasks. Plot macros capture and automate common math expressions.	
	Data Analysis and Graphical Tool • Plot macros capture and automate common math expressions. • Report templates can capture and automate the building of entire pages of data plots. These can be reused for model variations and similar models. • A library of over 200 mathematical functions is included and user defined math functions can be added. • Tool supports units starting from data import all the way through predefined functions. Conversion between units is possible.	

	• Automation tools for efficient data analysis and report generation • Contains a sophisticated math engine for performing complex mathematical operations or building custom math expressions	
6	The vendor or OEM should conduct Faculty Development Programs (3-days each) on the following domains: o Mechanisms and Kinematics simulation o Vehicle dynamics	
7	The vendor or OEM should provide a free Training Programs, for various domains of engineering. • The training programs should be conducted for total of 8 days in a calendar year. • Under this free training program, the vendor or OEM should have a dedicated website to register for such trainings. • The training classes should be at vendor/OEM's regional offices as well as university. • Some of the training that vendor/OEM should offer are: o Multibody Dynamics o Vehicle Suspension	
8	The vendor/OEM should provide certification program for the students, to improve their knowledge and productivity. Students can take free certification through the online portal of the OEM of the software tool. The certification program should be on: • Pre-processing and meshing • Mechanism Simulation	
9	The OEM/vendor should provide an online Learning Library to offer videos and resources that can be used to build the skills of the students.	
10	The vendor/OEM should provide the teaching material on the tools as mentioned below. • PPTs (for your presentations while teaching in the classroom) • Reading material (PDFs) for your students` self-learning • Tutorials - Handouts (PDFs) for your students • Model Files to practise	

11	The vendor/OEM should provide Internship Opportunity of eligible students; subject to their terms and conditions. The vendor/OEM should conduct tests and interviews of shortlisted students, once a year, to select students either for internship or as trainees. Subject to selection criteria. The selection should be based on eligibility and positions being available at OEM.	
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