TECHNICAL SPECIFICATIONS

Flight Simulator

Detailed technical specifications of the flight simulator:

1. **Supply, Installation, Testing & Commission:** Supply, Installation, Testing & Commissioning of, a motion platform mounted flight simulator with Visual system, Aerodynamic Model for Twin Engine Aircraft and simulation of environment with academic experimentation capability. It should also be equipped with electric force feedback system for flight controls along the three axes with differential toe-brakes.

2. **Simulator Computing Module:** The simulator computing module hardware shall primarily be based on 'commercial-off-the shelf equipment' based on open architecture to allow addition/alteration/deletion at a later date. The computation module should be capable of not having CPU loading of more than 75% at any given time. The visual generation module shall allow easy scene creation for both geo-typical and geo-specific data bases and all environmental conditions

   The Computing module should use suitable authentic licenses for all the software's and capable computational power for the application.

3. **Mechanical Structure:** The mechanical structure needs to replicate an aircraft cockpit with capability for reconfiguration of instrument panel. The structure mounted on motion platform should be capable to withstand normal operational stress, wear and tear. The structure should be corrosion resistant in its operating environment, should have a high-quality finish & maintenance friendly.

   Provisioning of light inside the cockpit is to be done without the filament of light source being visible to naked eye; the switches should be clearly visible without putting glare on the eye; the panel should be backlit for operating night time scenarios

4. **Simulated Aircraft:** The Simulator must simulate a multi-engine propeller powered aircraft to a high degree of realism and the supplier must prescribe & demonstrate procedures for validating the aerodynamic behavior of the simulated aircraft.

   The simulator should be capable of simulating different types of engine (reciprocating, turbine, turboprop, turbo shaft & turbofan), the user should have the capability to customize the simulated aircraft (fixed and rotary) and use reconfigurable cockpit layouts.

5. **Visual System:** The simulator should provide a complete, panoramic outside the window view of minimum of 180° Horizontal field of view by 70° Vertical field of view with a minimum refresh rate of 30 frames per second. This visual system should consist of a single continuous curved screen, projectors, IG HW controllers with GPU, and image generator SW. Worldwide terrain elevation model, scenery database, major and airports and airfields and weather effects of Visibility and RVR, Day/Night, Cloud layers, Rain/Snow/Hail, Icing conditions & Wind and Turbulences. The Visual System should be made up with COTS hardware with user specified specification to provide sharp and high definition imagery.

   The Supplier should also provide an interface for addition of photo realistic commercial FAA Level D capable visual system.

6. **Instrument Panel:** Houses the Glass Cockpit Instruments, All the dials and gauges, should replicate the aircraft simulated. The panel should be made up of material to handle the normal operating stress and not deform over usage period. The instrument panel area containing switches and knobs should be backlit to allow for scenarios night time flying capability.

User should be able to change the Glass Cockpit Instrument layout as per need, the supplier should provide a ready to use library of standard instrument with no additional cost.

The vendor/manufacturer should supply an all-glass Integrated flight instrument system typically composed of two display units, one serving as a primary flight display, and one as a multi-function display

The primary flight display shows the basic flight instruments, such as the attitude indicator, airspeed indicator, altimeter, heading indicator, and course deviation indicator. A small map called the "inset map" The MFD usually shows engine instrumentation and a moving map.

The multi-function display showing a moving map on the right side, and engine instrumentation on the left. It also shows information about nearest airports and NAVAIDs, Mode S traffic reports, terrain awareness and flight plan programming.

There should also be the capability of customizing the Human Machine Interface of the Instrument Panel by being able to display custom/user-built gauges on the same replica.

7. **Switch & Knobs:** The panel should have real tactile switches for operating essential avionics functions on board the aircraft with the corresponding switches and keys replicating the usage as on board the aircraft (Switch Types). These switches, knobs should be of finest standards for use in aviation should conform to quality standards of Avionics, they should be made of corrosion resistant material, shielded for EM Interference and Rotary Encoders, should be properly de-bounced while being capable of around 1 million rotation cycles

Figure 1: Instrument Panel & Flight Controls (Indicative)

8. **Simulation Engine and Aerodynamic Fidelity, and Gimbal Simulation:**

(a) **Simulation Engine and Aerodynamic Fidelity:** The Simulation Engine should be licensed for academic usage at IITB, and a software development kit should also be provided to customize the simulation engine for any modification, there should be an option to tweak aerodynamic & engine models programmatically and manually.

The simulation engine should have the capability of simulating flight dynamics for Fixed Wing and Multi Rotor UAVs and aircrafts and be able to simulate VTOL, VSTOL and hovering capabilities as applicable for the airframe.

(b) **Gimbal Simulation**

Gimbal Simulation Module should be able to stream or display the video as seen by a camera mounted on the aircraft. The user should have the capability to be able to see Optical Camera as well as Infrared Camera Video while being able to Pan the camera in 2 axes. There should be a capability to zoom the camera feed also. The point of view should move as the user flies the aircraft. There should also be an option to change the view point of such camera anywhere on the aircraft.

9. **Avionics (Radios and Indicators):** The simulator should be able to simulate different types of standard navigation equipment on board a modern aircraft which can be added to the aircraft as per need of IITB. The simulation should at least be able to provide capability of simultaneous usage of 2 VOR radios, 1 ILS, 1 ADF Radio & 1 GPS.

The Simulation should also be capable of providing interface for the following devices in simulation and Stimulation Mode (Actual Avionics Unit)

- NAV Radio
- Digital Flight Computers
- ADF Radios
- Auto Pilots
- Flight Control Actuators
- Flight Management System
- Flight Guidance Computer
- Flight Control & Augmentation System

The supplier must provide evidence for having experience in interfacing actual aircraft systems with simulation engine utilizing standard communication protocols such as A429, AFDX, CSDB, and the rest.

10. **Flight Controls:** The flight controls must be available for each pilot while being mechanically linked. The two sets of flight controls should contain an electric Force Feedback System (Control Loading) capable of simulating vibration, stall buffet and aerodynamic load gain forces. The Control loading system should be customizable and user should be able to change the force feedback profile as desired. The flight control system should operate at the lowest refresh rate of 200 Hz. The control loading system should also be capable of carrying out motion of flight controls following a simulated autopilot and capable of interfacing with an actual autopilot hardware/system.

The dual linked stick control at the minimum should meet the following functional requirements:

Parameter	Range/Value

Parameter	Range/Value
Peak Force Pitch and Roll	4.2 Nm /3.1 ft –lb.
Travel Pitch	20.5°
Travel Roll	20.5°
Power	300W
Operating Voltage	24VDC

11. Rudder Pedals with Toe brakes: Complete Rudder Axis Control with range and motion similar to the controls on actual aircraft, Variable friction/load Levels for pilot ease and scenario, Independent left & right toe brake axis motion, Self-cantering with adjustable damping. The rudder should have mechanical and electrical provisions for upgrade to control loading. The rudder pedals for the two pilots should be mechanically linked and corrected. The simulator should allow for lateral movement of the rudder or the seat to adjust for pilot/operator height variations.

The rudder pedal should meet the following force feedback and travel requirement:

Parameter	Range/Value
Peak Force	70 Nm
Travel	130mm / 5.1 in (linear)
Power	200W
Operating Voltage	24VDC

12. Electric Control Loading: The Flight Control System must include an Electric Control Loading system to recreate the control forces experienced by a pilot while operating flight controls in normal and abnormal flight phases, with the capability to edit and program the forces experienced by the pilot.

13. Motion System: The simulator should also include a 3 axis motion system with electromechanical actuators, frame, necessary drives and power supply, computer and safety system. The motion system should be interfaced with the simulation scenario for motion cueing while providing the provision to IITB to update the motion cueing logic and interface as and when needed. This motion system capable of providing motion cuing in 3 axis should be supplied with a user usable payload of more than 500Kg and overall payload of more than 1200Kg. The system must provide cuing for 15° Roll and 20° Pitch and should have a travel of more than 3 inches for simulating heave. The minimum rate of actuator motion should be able to simulate +/- 1 G and actuator velocity of 100m/sec for heave and 40°/sec for rotation. The motion code should also provide for user tuning and user software control for the motion platform.

14. Vibration Augmentation: The simulator should also be equipped with a system for augmenting and adding vibration feedback to flight control and the motion base as per the flight scenario.

15. Control Trims: The user should have a mechanism to control trim tabs as per the simulated aircraft with IITB be able to activate and de-activate the controls as per need.

16. **Flaps Control:** The Simulator should have a generic flaps control for all the flap settings as in the aircraft.

17. **Seats:** The Simulator should have 2 seats for the Pilot & Copilot. The simulator should have ample space for users to easily occupy the seats and exit.

18. **Maps and Navigation:** The cockpit should have to a capabilty to display navigation maps with updatable & user customizable navigation databse. The cockpit should also be simulation for widely used system for using such maps for navigation and available with glass cockpit moving maps.

Figure 2: Image showing a typical Glass Cockpit (Indicative)

19. **Multi Headset & Inter-communication Provision with Playback:** The simulator should contain an intercom system to provide for communication between Pilots, Co-Pilot & Instructor via VOX and PTT (push to talk) lines using the headsets the system should also be capable of recording the communication for playback. The intercom system should be based on VoIP technology and allow for future scaling in the number of participating radio operators

20. **Instructor Station for Supervisory Control and Data Acquisition:** The Instructor station should contain the following:

(a) Setting of Aircraft Position on

(I) Any Runway across the globe

(II) Runway Hold Positions

(III) Runway Circuit Positions

(IV) User Specific Position

(V) Slew Control

(b) Weather Control

(I) Setup Ambient Pressure, Temperature, Time of Day

(II) Rain and Snow with Variable Intensity

(III) Up to 3 Cloud Layers with User controlled cloud coverage

(IV) Runway Visibility Range and Fog Height

(V) General Visibility

(VI) Up to 3 Layers of Wind with Gusts & Turbulence

(VII) Lightning

(VIII) Wind Shear & Microbursts

(c) Program or Set Aircraft System & Create Failures

(I) General Engine Failures such as Fire

(II) General Instrument Failures such as Pitot Icing, Power & Fuel Failure

(d) Manage Fuel and Load

(I) Manage Overall Fuel Load

(II) Manage Passenger Load

(III) Visualize and Control Centre of Gravity

(e) Record Flight Data and Plot Graphically in real time with Ability to export Flight data to commercially available geo-maps & as a "comma separated values" file for analysis

(f) Pause, Flight Freeze Scenario

(g) IOT Enabled for Remote Diagnostics and Troubleshooting

(h) Navigation Database Manager

(i) Moving Maps with Capability to Reposition via Map

(j) Primary flight information in PFD format

(k) Approach View (Lateral & Vertical profile) and real time plot using approach plates or data driven charts

(l) Diagnostics - Real time health monitoring (sub systems) & dashboard for easy maintenance

21. Academic Usage Interface for Software: The simulator should be capable of interfacing with commonly used software such as MATLAB, Lab View, and Visual Studio and the rest. The supplier should provide source code for usage with rights to IIT to make changes to the source code. The Supplier must supply library example of at least a Flight Data Recorder and 3-axis Flight controllers.

IITB should also be provided the capability to add and design an Aircraft as per need to the simulator with the capability of adding programmatically controlled traffic.

22. Industry Standard Usage: The simulator should be capable of or based on industry standards such as HLA, DIS, FOM, and SISO, and the rest.

23. Experimentation Capability: The supplier should provide a list of experimentation that can be carried out for study flight performance, flight Control, flight guidance and navigation. The Supplier should provide a Lab Manual of sort and work with IITB to add experimentation.

24. Hardware Package: Hardware Package should include Cockpit, Instrument Panel, Flight Controls, Pilot

Seats, Sim Controller with GPU, IO Boards, GPUs, Routers, PDU, Rack, and the rest.

25. **Software Package:** Software Package should include Prepar3D Professional Plus with Software Development Kit (SDK), Aircraft Models, Aircraft Configurations, Windows OS and Instrumentation SW, IO SW & Diagnostic Utilities, and the rest.

26. **Academic Package (Generic):** Academic Package (Generic) should include SDK, Flight Data Recorder (FDR), Experimentation Capability, Aircraft Design Capability, and the rest.

27. **Cockpit Live Share:** Cockpit Live Share (at least 10 Instances) with required Software Version should be provided.

28. **Provision of Cooling/Ventilation:** Provisions should be made to dissipate the heat generated by the Equipment. Provisions to be made to maintain the cockpit environment well ventilated.

29. **Provision of Speakers:** To give an actual feel of the ground run, provision to create the sound using speaker is to be provisioned

30. **Provision for Remote Cockpit Desktop for Large Audience:** The simulator should have provision to allow basic instruments and outside view to be shared with a larger audience by the use of a Projector or Cockpit Sharing Equipment. The cockpit sharing system shall duplicate the simulated instrument panel and outside displays using a console to replicate the actual cockpit positions of such views.

31. **Certification Package:** This Certification Package should include Do 178 C Software Considerations in Airborne Systems and Equipment Certification as well as DO 333 Formal Methods.

32. **Installation & Commissioning:** The simulator shall be installed in full functionality and handed over in full functional condition to IITB at the location designated for delivery.

33. **Training, Development Program, Technical Literature, Deliverable:** The supplier should carry out extensive training program, which is to be conducted at IITB, as part of the delivery and should support future recurrent training programs on request as and when needed by IITB to train faculty members, staffs and students on various aspects of the simulator facility including software and hardware interfacing, experimentation and development of components and adding them to the simulation. For the user, the delivery of training material / documents, maintenance and usage shall be included. All Software manual used in the hardware shall be handed over. Detailed specifications of components utilized in making the hardware also required to be covered.

34. **Maintenance:** IITB Unit will nominate few people for a thorough training by the vendor/manufacturer to carry out necessary maintenance and troubleshooting. They will also work with the vendor/manufacturer as a point of contact for remote diagnostics using the internet and minor fixes and repair activities.

35. **Warranty:** A minimum of THREE year warranty on site from the date of commissioning. During the

warranty period, any un-serviceability in the simulator has to be attended and rectified by the seller at the installation site. All Repair/Replacement/Spares cost during warranty period will be fully borne by the seller.

36. **Please specify the following**:

(a) Power requirements

(b) Drives are all electric or not. If not, which drives are electric?

(c) Training period and method of training after installation and commissioning at IIT Bombay

(d) Integration of hardware plus software

(i) The time required for installation and commissioning

(ii) The requirement of civil, electrical, plumbing work, and the rest to be carried out by IIT for the simulator

(iii) Other, if any

37. The simulator software and interface should be capable of supporting and also interfacing with PC desktop, 3-Axis Angular Motion Simulator, and Hardware-In-Loop Simulation (HILS).

38. Installation and Commissioning by the supplier at no cost.

39. Detailed manuals of hardware and software in English along with electronic copies.

40. Upgradation of software should be free for first 5 years, which will be compatible to any higher version of windows operating system.

41. **Safety:** At all times, the simulator facility should ensure the operator's safely. Please specify in the technical bid the safety features, precautions and capabilities of your simulator hardware and software.

Appendix. Technical Compliance

Technical Paragraph	Requirement	Proposal Reference	Vendor Compliance	Vendors comments, if any
2	Simulator Computing Module: Based on Latest COTS Components with licensed software's	YES/NO		
3	Mechanical Structure: Reconfigurable Instrument Panel, Mounted on a Motion Platform	YES/NO		
3	Mechanical Structure: Treated for operational stress & corrosion	YES/NO		
4	Simulated Aircraft: Multi Engine Aircraft with Capability of Different Engine Types	YES/NO		
5	Visual Systems for a Vertical Field of View of 70° and Horizontal Field of View of 180°	YES/NO		
5	Visual Systems with Worldwide Terrain Database and Weather System	YES/NO		
5	Visual Systems with minimum refresh rate of 30 Frames per Second	YES/NO		
5	Visual Systems with one (1) Photorealistic Level D Airport	YES/NO		
6	Instrument Panel: Glass Cockpit Housed with one Screen as Primary Flight Display and other as Multi-Function Display	YES/NO		
6	Instrument Panel: Glass Cockpit backlit for night flying scenarios	YES/NO		
6	Instrument Panel: Reconfigurable Human Machine Interface	YES/NO		
6	Instrument Panel: Library of standard instrument panel gauges for use by IITB	YES/NO		
7	Switch's & Knobs: Aviation Grade hardware with extended usage life	YES/NO		
7	Switch's & Knobs: Supplier Manufactured Interface for Switches and Knobs	YES/NO		
8	Simulation Engine: Licensed for use by IIT-B with Software Development Kit	YES/NO		
8	Simulation Engine: Capability for adding user design and programmed aircraft models	YES/NO		
8	Simulation Engine: Capability for editing supplied aircraft models (1 Fixed Wind & 1 Rotary Wing)	YES/NO		
8	Simulation Engine: Capability of simulating Fixed Wing and Multi Rotor UAVs	YES/NO		
8	Gimbal Simulation: Capability of simulating video feed from a Gimbal	YES/NO		
9	Avionics: The simulator should be able to simulate standard navigation systems	YES/NO		
9	Avionics: Minimum 2 VOR Radios, 1 ADF Radios, 1 ILS and 1 GPS Radio	YES/NO		
9	Avionics: Interface capability for Actual Aircraft Hardware Units : NAV Radio	YES/NO		
9	Avionics: Interface capability for Actual Aircraft Hardware Units : Digital Flight Computers	YES/NO		
9	Avionics: Interface capability for Actual Aircraft Hardware Units : ADF Radio	YES/NO		
9	Avionics: Interface capability for Actual Aircraft Hardware Units : Auto Pilots	YES/NO		
9	Avionics: Interface capability for Actual Aircraft Hardware Units : Flight Control Actuators	YES/NO		
9	Avionics: Interface capability for Actual Aircraft Hardware Units : Flight Management System	YES/NO		
9	Avionics: Interface capability for Actual Aircraft Hardware Units : Flight Guidance Computers	YES/NO		

9	Avionics: Interface capability for Actual Aircraft Hardware Units : Flight Augmentation Systems	YES/NO		
9	Avionics: Capability & Experience for Avionics Protocols like A429, CSDB, AFDX etc.	YES/NO		
10	Flight Controls: Mechanically Linked Dual Pilot Flight Controls	YES/NO		
10	Flight Controls: Flight Control Refresh of 200Hz, Autopilot Following, Electric Force Feedback	YES/NO		
11	Rudder Pedal: Dual Rudder Control Mechanically Linked and Electric Control Loading	YES/NO		
11	Rudder Pedal: Electric Force Feedback	YES/NO		
11	Rudder Pedal: Toe Brake Independent for Left and Right	YES/NO		
12	Electric Control Loading: Electric Force Feedback System to generate control forces	YES/NO		
12	Electric Control Loading: Forces for normal and abnormal flight operations	YES/NO		
12	Electric Control Loading: Forces for vibration and flight control stall and buffets	YES/NO		
13	Motion System: Providing motion cuing in 3 axis with electro mechanical actuators, frame, necessary drives and power supply, computer and safety system.	YES/NO		
13	Motion System: Must provide cuing for 15° Roll and 20° Pitch and should have a travel of more than 3 inches for simulating heave	YES/NO		
13	Motion System: With a user usable payload of more than 500Kg and overall payload of more than 1200Kg.	YES/NO		
13	Motion System: Should be able to simulate +/- 1 G and a minimum actuator velocity of 100m/sec for heave and 40°/sec for rotation	YES/NO		
13	Motion System: Motion System programming Interface for IITB for modfying Motion Cueing	YES/NO		
13	Motion System: Motion code should provide for user tuning and user software control for the motion platform, and and software SDK for user development should be provided.	YES/NO		
14	Vibration Augmentation: Vibration for Flight Controls & Motion System as per Flight Scenario	YES/NO		
14	Vibration Augmentation: Vibration system Programatic control for IITB	YES/NO		
15	Control Trims: Control Trims for all trim tabs as and when available on the Aircraft	YES/NO		
16	Flaps Control: Physical Control for Flaps with IIT-B customizable interface for flaps as per AC	YES/NO		
17	Seats: Dual Seats for Pilot & Co - Pilot with Lateral Movement Control	YES/NO		
18	Maps & Navigation: Updatable Database for moving Maps and Navaids	YES/NO		
19	Multi Headset & Intercom System: PTT and VOX system for Pilot, Co-Pilot and Instructor	YES/NO		
19	Multi Headset & Intercom System: Capability to Record	YES/NO		
20	Instructor Station : Position Controls : Any Runway, Runway Hold, Runway Circuit Position, GPS Specified Location, Slew Controls	YES/NO		
20	Instructor Station : Weather Controls: Ambient Temperature & Pressure, Rain, Snow, Clouds Layer (Min 3), Wind Layers (3), Gusts, Lighting in, Turbulence, Shear, Microburst, Runway Visibility, Fog Height, General Visibility	YES/NO		
20	Instructor Station : Weather Controls: Aircraft & System Failure: Engine Fail, Fire & Instrument Failures	YES/NO		

20	Instructor Station : Fuel & Load Controls: Overall Fuel Load, Passenger Load, Visualize Centre of Gravity	YES/NO		
20	Instructor Station : Record Flight Data and Plot Graphically in real time with Ability to export Flight data to commercially available geo-maps & as a “comma separated values” file for analysis	YES/NO		
20	Instructor Station : Pause, Flight Freeze Control	YES/NO		
20	Instructor Station : Remote Diagnostic & Trouble Shooting	YES/NO		
20	Instructor Station : Navigation Database Editor	YES/NO		
20	Instructor Station : Moving Maps with Capability to Reposition via Map Control	YES/NO		
20	Instructor Station : Approach View (Lateral & Vertical profile) with real time data driven charts	YES/NO		
20	Academic Software Interface: Interface for MATLAB, LABView, VISUALSTUDIO	YES/NO		
20	Academic Software Interface: Example source code for Data recorder	YES/NO		
20	Academic Software Interface: Example source code for 3 Axis Flight Controller	YES/NO		
23	Experiments: Supplier provided lab manual for IITB & Supplier Discussed List of Experiments for Aircraft Performance, Flight Controls & Flight Guidance	YES/NO		
33	Faculty & Student Development Program: Once time along with Delivery Training for various aspects of simulator interfaces, hardware and software and detailed training in simulator usage and research capability	YES/NO		
33	On request Additional training in future as per the needs of IITB	YES/NO		
23	Indigenous Manufacturing Breakdown	YES/NO		
29	Provision for Speakers to provide actual feel of ambient sound as in the cockpit	YES/NO		
30	Provision for Remote Cockpit Replicas	YES/NO		
32	Installation & Commissioning at IIT-B designated location	YES/NO		
33	Training & Technical Literature for Simulator Usage and Maintenance Activities	YES/NO		
37	Simulator software and interface: Should be capable of supporting and also interfacing with PC desktop	YES/NO		
37	Simulator software and interface: Should be capable of supporting and also interfacing with 3-Axis Angular Motion Simulator	YES/NO		
37	Simulator software and interface: Should be capable of supporting and also interfacing with Hardware-In-Loop Simulation (HILS)	YES/NO		
24	Hardware Package: Should include Cockpit, Instrument Panel, Flight Controls, Pilot Seats, Sim Controller with GPU, IO Boards, GPUs, Routers, PDU, Rack, etc.	YES/NO		
25	Software Package: Should include of Prepar3D Professional Plus with Software Development Kit (SDK), Aircraft Models, Aircraft Configurations, Windows OS, Instrumentation SW, IO SW & Diagnostic Utilities, etc.	YES/NO		
26	Academic Package (Generic): Should include SDK, Flight Data Recorder (FDR), Experimentation Capability, Aircraft Design Capability, etc.	YES/NO		
27	Cockpit Live Share: Cockpit Live Share (at least 10 Instances) with required Software Version should be provided.	YES/NO		
35	Warranty: 3 year standard manufacturer’s warranty	YES/NO		
31	Support for Certification Package which includes DO-178 & D0-331	YES/NO		