Raj Verma

Pre-final year Undergraduate | Indian Institute of Technology, Kanpur
Majors : Mechanical Engineering | Electrical Engineering
Minors : Industrial and Management Engineering

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Academic Qualifications

Year	Degree/Certificate	Institute	CPI/%
2025 (Exp.)	B.Tech. (Double Major)	Indian Institute of Technology, Kanpur	8.4/10
2020	CBSE (XII)	M.G. Convent School, Lucknow	93.6%
2018	ICSE (X)	St. Ann's Convent School, Lucknow	92.6%

Achievements ❈ *Credentials*

- Granted **SURGE fellowship** for research in SURGE 2022, awarded to most accomplishing **599 students nationwide**
- Received **Academic Excellence Award 2020-21**, among **top 50 students** in IIT-K for performance in 1st semester
- Secured **All India Rank 4297** in Joint Entrance Examination Advanced 2020 among **2.5 Lakhs** shortlisted candidates
- Secured an **All India Rank 6024** in Joint Entrance Examination Mains, among **1.1 million** candidates
- **Qualified Kishore Vaigyanik Protsahan Yojana(KVPY)** SA Exam Round 1, among top 4000 students nationwide
- **Qualified Stage 1 of NTSE** (National Talent Search Examination), among 7500 selected for Stage 2 nationwide

Research Experience

Engine Research Laboratory, IIT-K | Research Intern ⌂ ❈*Certificate* *(October'22 - March'23)*

- Conducted research in I.C. engines, specializing in **combustion optimization, emission analysis, and alternative fuels**
- Utilized state-of-the-art testing instruments, including **engine test beds**, **dynamometers(DYNOMERK^{TM})**, and **exhaust gas particle sizers(HORIBA^{TM})**, to analyze engine performance, vehicle vibrations and efficiency of combustion processes
- Developed expertise in **MATLAB** and **MATLAB G.U.I. development** for data analysis and visualization in engine research making code for **fuel spray imaging** data from various methods like **Schlieren, P.I.V.** and **thermal camera images**
- Collaborated with **industry and research partners** to address challenges in engine technology for improved efficiency and reduced emissions such as **India's first D.M.E. tractor** with **Tafe Motors And Tractors Ltd. (T.M.T.L., Alwar)**
- Operated various types of engines such as **Gasoline Compression Ignition (G.C.I.) engine, Gasoline Direct Injection (G.D.I.) engine and Single Cylinder Optical Research Engine (S.C.O.R.E)** using various alternative fuels
- Worked on **Laser Ignition Engine** working on Hydrogen & C.N.G. blends and performed various **Constant Volume Compression Chamber (C.V.C.C.) experiments with P.I.V. and P.D.I.** to find out complete spray characteristics
- Utilized simulation software like **Converge^{TM}** to simulate the effects of intake manifolds and injection positioning on fuel spray, enhancing understanding of engine behaviour, learned basics of **OpenFoam for modelling multi-phase flows**
- Learned about **various sensors and their integration with E.C.U.** to calibrate **Motec^{TM} E.C.U.** for engine optimisation

Projects

▶ Conversion of Mechanical Direct injection single cylinder Diesel engine to dual fuel C.R.D.I. and P.F.I. engine
Mentor: **Prof. Avinash K Agarwal***(Dept. of ME, I.I.T.K.)* | Co-Mentor: **Lt. Cdr. Tushar Jain** ❈ *LOR* *(May'23 - present)*

- Converted **Kirloskar DM10** engine from mechanical direct injection to dual fuel electronic **Common Rail Direct Injection (C.R.D.I.)** for injecting Diesel as well as **Port Fuel Injection (P.F.I.)** enhancing its fuel delivery efficiency using alternate fuels
- Conducted engine inspection to address potential wall impingement issues and ensure smooth integration of new components
- Replaced mechanical injector with a **BOSCH^{TM}** solenoid injector connected to a common rail and **DELPHI^{TM}** high-pressure pump for precise and efficient Diesel delivery and **Royal Enfield (RE^{TM})** RE500 injector for port fuel delivery
- Developed electronic injector control system inspired by **Motec-M41** for simultaneous control of Diesel and Methanol injector control and integrated it with **DYNOMERK^{TM}** dynamometer for accurate engine control and performance analysis capabilities
- Multiple iterations of the fuel injection circuit were evaluated, with each subsequent iteration demonstrating superior performance and the **final circuit to be manufactured industrially** ⌂

▶ Design and Implementation of a custom built Dynamometer for U.A.V. Engine testing and performance analysis
Mentor: **Prof. Avinash Kumar Agarwal***(Department of Mechanical Engineering, I.I.T.K.)* *(May'23 - present)*

- The project was aimed at creating a dedicated small test bed with a custom dynamometer with a **DC motor** from a treadmill and **in-house made motor controller** for **U.A.V. engine** testing and evaluation
- Tested a small U.A.V. engine on a **MAGTROL^{TM}** industry-standard dynamometer for the validation of the new dynamometer
- Built an in-house **P.W.M. D.C. motor controller** for precise torque and speed control enabling advanced testing capabilities allowing for precise adjustments in **torque and speed**, ensuring the dynamometer could accurately simulate various operating conditions as stated as standards for U.A.V. Engine testing ⌂

▶ Reinforcement learning-based design of H.V.A.C. Systems | *A.M.E., I.I.T. Kanpur* ⌂ *(Jan'23 - March'23)*

- Employed reinforcement learning, a subfield of machine learning, to optimize the design of the **Heat Ventilation And Cooling (HVAC) system**, enabling intelligent decision-making based on environmental feedback
- Incorporated techniques to develop adaptable models that learn from data and adjust system parameters for enhanced efficiency
- Demonstrated **the potential of reinforcement learning in HVAC systems**, showcasing its ability to create intelligent and autonomous control strategies that adapt to changing conditions and optimize energy consumption

▶ Image Processing | *Course Project (EE-604)* ⌗ *(Aug'22 - Nov'22)*
Mentor: **Prof. Tushar Sandhan** | *Professor, Department of Electrical Engineering, I.I.T.K.*

- Learned Image Processing basics using **OpenCV** including **filters, hough transform, edge and contour detection**
- Used basic **OpenCV tools** for making plots and image manipulation **to solve a Jigsaw puzzle** and **analyze whether two cyclones would collide in the future given their current positions**
- Incorporated the use of **Bilateral filter** for denoising an image, further implementing **bilateral up-sampling** for colourizing an image when provided with its **downsampled colour map**

▶ C.N.C. Milling Simulation | *Course Project (ME-361)* ⌗ *(Oct'22 - Nov'22)*
Mentor: **Prof. Mohit Law** | *Professor, Department of Mechanical Engineering, I.I.T.K.*

- Conducted a comprehensive literature review to gain insights into force characteristics specific to **half-milling and full-milling operations**, ensuring the accuracy and reliability of the simulated results with that present in the literature
- Used **MATLAB** to model and analyze the load characteristics on a tool during **half-milling and full-milling C.N.C. operations**, enabling a better understanding of the machining process

▶ Dual Lathe Machine | *S.U.R.G.E. 2022* ⌗ *(April'22 - August'22)*
Mentor: **Prof. Ishan Sharma** | *Professor, Department of Mechanical Engineering, I.I.T.K.*

- Designed a **user-friendly versatile dual (horizontal and vertical) Lathe Machine** prototype for wood turning, enabling the simultaneous production of **4 nested dolls** allowing even unskilled individuals to operate the machine
- Employed rigorous stress analysis techniques of stress-concentrated regions using **ABAQUS and Fusion in-built ANSYS support** for enhancing the **machine's structural integrity and optimising performance**
- Secured a patent for the **chuck design**, a crucial component of the Lathe Machine, which exhibited innovative features to **enhance clamping precision and facilitate swift material changes** making it far better than conventional chucks **⌁ AUTODESK**
- The project culminated in the creation of a comprehensive final **C.A.D. design for the Dual Lathe Machine**. This integrated design encompassed all components, ensuring seamless functionality, high efficiency, and scalability **⌁ AUTODESK**

▶ Designing of a cheap Micro-Manipulator *(July'22 - Sept'22)*
Mentor: **Prof. Manjesh Singh** | *Assistant Professor, Department of Mechanical Engineering, I.I.T.K.*

- Designed a **low-cost Micro-Manipulator** controlled by **servo motors** using Arduino and an **Arduino-based G.U.I.**
- Conducted **literature review on Micro-Manipulators** and their **working mechanisms realisation** using servo motors
- Unfortunately, the project was halted due to budget approval challenges and inefficiency of servo motor precision and challenging costs of making the device resulting in the **non-manufacturing of the Micro-Manipulator**

▶ Probe station for Micro-Manipulators ⌗ *(July'22 - Sept'22)*
Mentor: **Prof. Manjesh Singh** | *Assistant Professor, Department of Mechanical Engineering, I.I.T.K.*

- Developed a **cheap alternative Probe station** for attaching colloidal particles **to Atomic Force Microscope (A.F.M.)** tips
- Conducted literature review on **Stereo microscopes** to select an appropriate model for integration in probe station
- Utilized **Fusion 360** to design the probe station, incorporating insights from analyzing various pre-existing probe station designs
- Leveraged **3D printing technology** to efficiently manufacture various parts of the probe station
- Integrated the stereo microscope into the probe station for precise positioning of **colloidal particles** on **A.F.M. tips**.

▶ Portable Tribometer | *Course project (ME-222)* ⌗ *May'22*
Mentor: **Prof. Chanraprakash Chindam** | *Professor, Department of Mechanical Engineering, I.I.T.K.*

- Developed a **portable pin-on-disc Tribometer** to measure the wearing coefficient of various material systems
- Built the Tribometer from scratch, incorporating a **small weighing machine** to accurately calculate **friction force**
- Conducted experiments using different **metal pins(e.g., Aluminium, Mild Steel)** to measure wear rate and wear coefficient
- Measured the wear coefficient of soft metals like **Aluminium** and **failed for Mild-Steel** using the pin-on-disc Tribometer

▶ Rotating Expanding table | *Course project (TA-201)* ⌁ AUTODESK *Nov'21*
Mentor: **Prof. Vivek Verma** | *Professor, Department of Material Science & Engineering, I.I.T.K.*

- Conducted an extensive literature review on various expanding table designs to gather inspiration and working mechanisms
- **Utilized Fusion 360** to design a functional CAD model of a rotating expanding table, incorporating innovative features
- Optimized part designs and performed a thorough analysis to ensure structural integrity under different load cases
- Created a **C.A.D. model of an expanding table** that exhibits a significant increase in surface area when fully expanded

Mentored Projects

Image Processing in MATLAB | *A.M.E., IIT Kanpur* *Jan'23 - April'23*

- Teaching **40 students about fundamentals of MATLAB** and **Image processing concepts** using various examples
- Teaching students to gather data such as penetration length and plume area from a set of Fuel injection sprays
- Teaching students about **Image Processing Toolbox and application development in MATLAB**

Last Mile Transporter (LMiT 22) | *Robotics Club, IIT Kanpur* *May'22 - July'22*

- LMiT is a delivery robot originally designed to deliver small loads within hostels
- Responsible for teaching students about design and simulation software such as **Fusion 360 and Abaqus**
- Responsible for design and manufacturing of the complete robot and a non-pneumatic tyre used in the delivery robot

Holonomic Advanced Mechatronic Droid (HAM-D) | *Robotics Club, IIT Kanpur* *May'22 - July'22*

- Designed a small robot inspired by BB-8, HAM-D using the mechanism of a **2 wheel self-balancing robot**
- Responsible for teaching students about design, simulation and CAM softwares such as **Fusion 360 and Abaqus**
- Designed the complete structure of the robot in Fusion 360 and manufactured the complete robot

Rover Base | *Robotics Club, IIT Kanpur*   *May'22 - July'22*

- Base of the Mars rover was designed as a summer project to compete in **U.R.C.(University Rover Championship)**
- Responsible for teaching students about design, **simulation and CAM softwares such as Fusion 360 and Abaqus**
- Performed an extensive analysis and simulation of each and every part to be used in the base of the rover

Positions of Responsibility

Career Department Mentor(C.D.M.) | *Mechanical Department (Academics and Career council)*   *July'23-present*

- Worked in collaboration with the research wing and career development wings of the **Academics and Career council**
- Organized regular formal and informal sessions for the entire department or their batches of assigned mentees regarding sem-exchange, research scholarships, international opportunities, internships, industrial scope, etc
- Acted as a link between intern core team, companies and Students during intern process.

Problem Statement Lead (I.S.R.O. Moon mapping challenge) | *Inter I.I.T. Tech 11.0* ৬   *February '23*

- Secured the **Bronze Medal** in the competition among the **21 participating** I.I.T.s   ✹*Certificate*
- Led the team for the development of an **AI/ML model** to generate a high-resolution map of the moon using **Chandrayaan-1, Chandrayaan-2** Orbiter's imaging payloads considering only **OHRC** and **TMC** images
- Created alternative viewing method of the **LSB2 images** using **MATLAB** apart from the **pre-existing PDS4 viewer** as every image was nearly **10 Gigabytes in size with a pixel depth of 16 bits**
- Generated a **global lunar atlas (digital) with the help of MATLAB**, based on the medium/low-resolution data available by creating an **effective image stitching method** and creating data store for such large-size images
- Developed an innovative AI/ML model utilizing overlapping data from the **Orbiter Higher Resolution Camera (OHRC) and Terrain Mapping Camera-2 (TMC-2)** payloads to generate high-resolution lunar terrain images

Organizer 7ᵗʰ Sustainable Energy and Environmental Challenges Conference | I.S.E.E.S.   ✹*Certificate*   *Dec'22*

- Responsible for **managing hospitality of guests at I.I.T. B.H.U. and nearby available hotels**
- Simultaneously managed **3 tracks for various posters and research thesis presentation**
- Responsible for managing **High tea** for the guest during **mid-conference breaks**
- Responsible for **distribution of certificates and bill receipts** for the non-invited speakers

Senior Academic Mentor (S.A.M.) | *Dynamics(ESO209)*   *July'22 - Jan'23*

- Voluntarily helping students academically with **Counselling Service Core team members (CTMs)**
- Responsible for teaching and helping students about various concepts in **ESO209(dynamics)**
- Providing academic help to students unable to perform well academically

Technical Skills

- **Computer Aided Design software:** Fusion 360, Autodesk Inventor, Solidworks, KiCAD, Autodesk EAGLE
- **Analysis and Simulation software:** OpenFoam, Abaqus, Lotus-Shark, GIM, Autodesk C.F.D., Fusion 360(inbuilt simulation)
- **Computer Aided Manufacturing software:** Fusion 360(inbuilt manufacturing), MasterCam
- **Programming Languages:** C/C++, Python, Java, MATLAB, Simulink, Arduino framework
- **Video editing:** Adobe After Effects, iMovie, Adobe Premier rush

Relevant Courses

Alternative fuels & advancement in I.C. engines*****	Image Processing	Energy Systems*****
Microelectronics	Power Electronics	Vibration & Controls
Manufacturing Science & Technology	Energy system-I*****	Advance Mechanics of Solids
Multivariate Calculus*****	Nature and properties of Materials******	Mechanics of Solids
Dynamics *****	Introduction to manufacturing processes*****	Engineering Graphics*****
Engineering Design and Graphics *****	Partial Differential Equation	Introduction to Complex Analysis
Linear Algebra and Differential Equations	Thermodynamics	Fluids
Fundamentals of Computing	Introduction to Electrical Engineering	Introduction to Electronics

* : Awarded A grade   ** : Awarded A* grade   ᵒ : online course