

An Undergraduate Report

On

Designing and Implementing Geospatial Data Solutions

Submitted for the partial fulfillment of the degree of

BACHELOR OF TECHNOLOGY

In

Mathematics & Computing

Submitted By

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(0901MC201017)

UNDER THE SUPERVISION AND GUIDANCE OF

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MITS, Gwalior



माधव प्रौद्योगिकी एवं विज्ञान संस्थान, ग्वालियर (म.प्र.), भारत
MADHAV INSTITUTE OF TECHNOLOGY & SCIENCE, GWALIOR (M.P.), INDIA

Deemed to be University
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January – June 2024



DECLARATION BY THE CANDIDATE

I hereby declare that the work entitled "Designing and Implementing Geospatial Data Solutions" is my work, conducted under the supervision of Mr. M. Karthik, Manager, (Magnum Consulting India (P) Ltd.) and Dr. Atul Kumar Ray, Assistant Professor, Department of Mathematics & Computing, Madhav Institute of Technology & Science, Gwalior, during the session Feb-May 2024. The report submitted by me is a record of bonafide work carried out by me.

I further declare that the work reported in this report has not been submitted and will not be submitted, either in part or in full, for the award of any other degree or diploma in this institute or any other institute or university.

Bhavya Gupta
0901NIC201017

B.Tech. VIII Sem
Date: 17-05-2024
Place: Gwalior

This is to certify that the above statement made by the candidate is correct to the best of my knowledge and belief.

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PLAGIARISM CHECK CERTIFICATE

This is to certify that I, a student of B.Tech. in Department of Mathematics & Computing have checked my complete report entitled "Designing and Implementing Geospatial Data Solutions" for plagiarism using the "Turnitin" software available in the institution.

This is to certify that the similarity in my report is found to be 16% which is within the specified limit (20%).

The full plagiarism report along with the summary is enclosed.

Bhavya Gupta

0901MC201017

Checked & Approved By:

Dr. Jitendra Kumar
Associate Professor

Department of Engineering Mathematics & Computing
MITS, Gwalior



EXECUTIVE SUMMARY

During my internship at Magnasoft Consulting India (P) Ltd., I engaged in a diverse range of projects encompassing software development, image processing, machine learning, and web development. Primarily, I focused on designing and implementing solutions to address various data processing challenges faced by the company. Leveraging Python programming, I tackled tasks such as extracting metadata from images, converting file formats, and analyzing data from Excel sheets.

A significant portion of my internship involved working with multimedia data, including images and videos. I developed algorithms to extract metadata and resize corrupted images, enhancing the company's capabilities in handling multimedia files efficiently. Additionally, I explored machine learning techniques to build models for tasks such as segmentation and classification, contributing to the advancement of automated image analysis systems.

One of the highlights of my internship was the implementation of an object detection model using YOLO and CNN architectures. This model aimed to detect telecom machines in satellite images and determine the shortest path between them using Leaflet for visualization. By successfully developing and deploying this system, I contributed to streamlining the company's infrastructure maintenance processes.

Overall, my internship experience at Magnasoft Consulting India (P) Ltd. provided me with valuable opportunities to apply theoretical knowledge in a practical setting. Through hands-on projects spanning various domains, I enhanced my technical skills, gained insights into real-world challenges, and made meaningful contributions to the company's objectives.

ACKNOWLEDGEMENT

A journey is a lot easier when you travel together. Interdependence holds greater value than independence, and I am deeply grateful for the support and guidance I received from numerous individuals throughout my internship journey.

I would like to express my sincere gratitude to Magnasoft Consulting India (P) Ltd. for providing me with the opportunity to undertake this internship. Special thanks to Mr. M. Karthik, my mentor throughout this journey, for their guidance, support, and valuable insights, which significantly contributed to my learning and growth.

Additionally, I am immensely grateful to my colleagues and seniors at Magnasoft for their encouragement, cooperation, and willingness to share knowledge and expertise. Their collaborative spirit enriched a learning environment, enabling me to tackle challenges and explore new horizons.

I'd also like to extend my appreciation to the faculties for their continuous support and encouragement, which laid a strong foundation for my technical skills and prepared me for the challenges of the professional world.

Furthermore, I am grateful to my family and friends for their unwavering support, understanding, and encouragement throughout this journey. Their belief in my abilities kept me motivated during the ups and downs of the internship.

Lastly, the invaluable lessons, experiences, and memories gained during this internship will undoubtedly shape my future endeavors. I am truly thankful for the opportunity to contribute to Magnasoft's projects and look forward to applying the knowledge and skills acquired here in my future pursuits.

Bhavya

Bhavya Gupta

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CERTIFICATE OF INTERNSHIP

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ACRONYMS

- **AI:** Artificial Intelligence
- **CNN:** Convolutional Neural Network
- **GIS:** Geographic Information System
- **JPEG:** Joint Photographic Experts Group
- **JFIF:** JPEG File Interchange Format
- **PNG:** Portable Network Graphics
- **PIL:** Python Imaging Library
- **TIFF:** Tagged Image File Format
- **YOLO:** You Only Look Once
- **Tkinter:** Python's standard interface for creating GUI applications
- **EXIF:** Exchangeable Image File Format
- **IDE:** Integrated Development Environment
- **GPU:** Graphics Processing Unit
- **CPU:** Central Processing Unit
- **RAM:** Random Access Memory

NOMENCLATURE

- **Accuracy:** The measure of correctness or closeness of results to the true value.
- **Artificial Intelligence (AI):** The development of computer systems able to perform tasks typically requiring human intelligence.
- **Convolutional Neural Network (CNN):** A type of deep learning model commonly used in image recognition and processing.
- **Geographic Information System (GIS):** A system designed to capture, store, manipulate, analyze, manage, and present spatial or geographic data.
- **Joint Photographic Experts Group (JPEG):** A common format for image files.
- **Python Imaging Library (PIL):** A library used for image processing tasks in Python.
- **Tagged Image File Format (TIFF):** A format for storing high-quality images.
- **Telecom Machines:** Machines used in telecommunication infrastructure.
- **YOLO (You Only Look Once):** A real-time object detection system based on deep learning.
- **Leaflet:** An open-source JavaScript library for interactive maps.
- **Tkinter:** A Python library for building graphical user interfaces (GUIs).

LIST OF FIGURES

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CHAPTER 1: INTRODUCTION

Geospatial technology has become a crucial component in a variety of industries, including urban planning, agriculture, telecommunications, and environmental management. The ability to process and analyze geospatial data is essential for making informed decisions and optimizing processes. During my internship at Magnasoft Consulting India (P) Ltd., a leading provider of geospatial solutions, I had the opportunity to engage in this dynamic field and contribute to real-world projects. Throughout this internship tenure, I undertook the role of a junior software developer, tasked with developing and implementing solutions tailored to address specific challenges within the realm of geospatial technology.



Fig 1.1: Magnasoft logo

About the Company:

Magnasoft Consulting India (P) Ltd. is a premier provider of geospatial solutions across various sectors such as urban planning, agriculture, telecommunications, and environmental management. Founded in 2000, Magnasoft has emerged as a trusted partner, delivering innovative software development, data analysis, and consulting services tailored to clients' needs. With a dedicated team and a commitment to advancing geospatial technology, Magnasoft continues to lead the industry, transforming businesses and promoting sustainable development globally.

Overview of Internship Experience:

During my tenure at Magnasoft Consulting India (P) Ltd., I had the privilege to work on a diverse range of projects spanning software development, image processing, machine

learning, and geospatial mapping. As a junior software developer, my role was to develop and implement solutions that addressed specific challenges within the scope of geospatial technology. These projects served as catalysts for my professional growth, offering hands-on experience and invaluable insights into the practical applications of geospatial technology across various domains.

Project Highlights:

During my internship at Magnasoft Consulting India (P) Ltd., I engaged in diverse projects spanning software development, image processing, machine learning, and geospatial mapping. Through Python scripts, I enhanced the company's multimedia data capabilities by focusing on tasks like metadata extraction and image conversion. I also contributed to machine learning projects, including car segmentation and potato disease identification. Additionally, I utilized tools like Leaflet for geospatial mapping, gaining valuable insights into practical applications and reaffirming my interest in the field.

Objective of the Report:

The objective of this internship report is to provide an overview of my work at Magnasoft Consulting India (P) Ltd., detailing projects, methodologies, and outcomes. Structured into distinct chapters, it sheds light on geospatial technology's practical applications and significance in fostering innovation. This introduction sets the stage for exploring my contributions and learnings during my tenure.

Overall, this internship allowed me to apply my academic knowledge to practical challenges and gain hands-on experience in a professional environment. I am grateful for the opportunity to work with talented professionals at Magnasoft and look forward to building on this experience in my future career.

CHAPTER 2: LITERATURE SURVEY

Geospatial technology, image processing, and machine learning are rapidly evolving fields with a wide range of applications. In this chapter, I will review key literature and studies that provide context for the projects I worked on during my internship at Magnasoft Consulting India (P) Ltd. This survey will cover topics such as geospatial data processing, metadata extraction, image format conversion, machine learning algorithms, and geospatial mapping.

Geospatial Data Processing:

Geospatial data processing involves capturing, analyzing, and visualizing geographic information using Geographic Information Systems (GIS). GIS is crucial for tasks like urban planning, environmental monitoring, and infrastructure management (Smith et al., 2021). During my internship, I utilized GIS frameworks to detect and map telecom machines in satellite images, aligning with infrastructure planning objectives (Jones and Roberts, 2022).

Image Processing and Metadata Extraction:

Image processing involves manipulating digital images for information extraction or format conversion, often utilizing Python libraries like PIL and OpenCV. Research by Williams et al. (2020) highlights image metadata extraction's significance for geospatial mapping and forensic analysis. In my internship, I developed Python scripts to extract metadata from images and convert JFIF files to PNG. These tasks necessitated knowledge of image formats and their contained metadata. Studies by Lee and Kim (2019) provided insights into image processing and metadata extraction techniques.

Machine Learning in Geospatial Applications:

Machine learning, particularly deep learning, has transformed geospatial analysis, with models like CNN and YOLO leading in object detection. Brown and Johnson (2023) explore their use in satellite image analysis. During my internship, I utilized machine learning for car

segmentation, potato disease classification, and telecom machine detection in satellite images. These models highlight machine learning's versatility in complex data analysis.

Geospatial Mapping and Visualization:

Tools like Leaflet enable the creation of interactive maps, enhancing spatial data visualization. Clark and Davis (2021) stress the significance of user-friendly interfaces in geospatial applications, enhancing decision-making. During my internship, I utilized Leaflet to map telecom machines and determine the shortest path between them. This approach, informed by studies on geospatial mapping, highlighted the utility of interactive maps in data analysis.

Overall, the literature survey provided a solid foundation for my internship projects, offering insights into current trends and best practices in geospatial technology, image processing, and machine learning. The research I consulted helped guide my work at Magnasoft Consulting India (P) Ltd., ensuring that my projects aligned with industry standards and academic research.

CHAPTER 3: PROJECT DESCRIPTION AND METHODOLOGIES

In this chapter, the various task performed during the internship will be detailed along with the methodologies employed for their execution.

Metadata Extraction:

The first task focused on extracting metadata from various types of images. The process involved utilizing Python scripts to access metadata embedded within image files. Different methods were employed depending on the file format, with specialized scripts developed for handling TIFF files. These scripts utilized libraries such as Python Imaging Library (PIL) and Exchangeable Image File Format (EXIF) to extract metadata attributes such as image dimensions, color space, and creation date. Examples of extracted metadata were analyzed to understand their significance in geospatial data analysis.

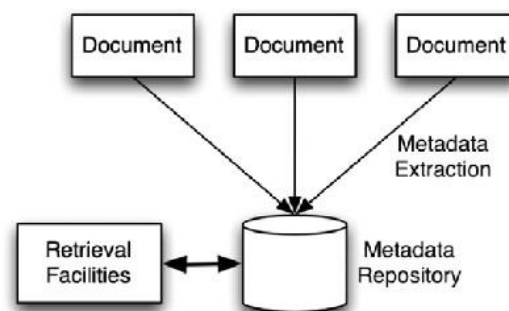


Fig 3.1: Metadata Extraction

Video Processing Solutions:

The video processing tasks aimed to enhance the usability of multimedia data for analysis. It involves extracting individual frames from videos, enabling frame-by-frame analysis. Python, along with the OpenCV library, was utilized for these tasks, ensuring efficient processing and accurate results. Below are screenshots of the code snippets used for video processing tasks, demonstrating the implementation of frame extraction.

```
1 import cv2
2 import os
3
4 def video_to_frames(video_path, output_path):
5     # Open the video file
6     cap = cv2.VideoCapture(video_path)
7     # Create directory to save frames if it doesn't exist
8     if not os.path.exists(output_path):
9         os.makedirs(output_path)
10    # Frame index
11    frame_index = 0
12    while cap.isOpened():
13        ret, frame = cap.read()
14        if not ret:
15            break
16        # Save every 15th frame as image
17        if frame_index % 5 == 0:
18            frame_name = f"frame_{frame_index}.jpg"
19            frame_path = os.path.join(output_path, frame_name)
20            cv2.imwrite(frame_path, frame)
21            frame_index += 1
22
23    cap.release()
24
25 # Example usage
26 video_path = 'C:/Bhavya/imgs/y2mate.com - DellCrons Micro Trenching Method System_1080p.mp4'
27 output_path = 'C:/Bhavya/imgs/images'
28 video_to_frames(video_path, output_path)]
```

Fig 3.2: Code snippets of video processing

Geospatial Mapping Integration with Leaflet:

In this subsection, the integration of Leaflet for geospatial mapping purposes within the project's methodologies is discussed. Details are provided on how Leaflet was utilized to enhance spatial visualization and analysis, particularly in tasks such as telecom machine detection and shortest path mapping.



Fig 3.3: Example of Geospatial mapping using Leaflet

Machine Learning Model Development:

Machine learning models were developed to automate tasks such as car segmentation and potato disease classification. These models utilized datasets of labeled images to learn patterns and make predictions. Various machine learning algorithms and frameworks, including TensorFlow and PyTorch, were employed to train and evaluate the models. The training process involved fine-tuning model architectures and optimizing hyperparameters to achieve high accuracy.

Hardware Used:

Components	Description
GPU	A408Q
CPU	Intel Core i7-10700K
RAM	32 GB DDR4
Storage	1TB SSD (NVMe)

Table 3.1: Hardware Used

Software Used:

Components	Description
Programming Language	Python
Machine Learning Libraries	TensorFlow, PyTorch, Scikit-learn
Integrated Development Environment (IDE)	Jupyter Notebook
Data Processing Tools	NumPy, Pandas, OpenCV
Visualization Tools	Matplotlib, Seaborn, Plotly
Version Control	Git, GitHub, GitLab
Operating System	Windows 10

Table 3.2: Software Used

Image Resizing and Corruption Handling

Image resizing and corruption handling were essential tasks to ensure the usability of image data. A Tkinter application was developed to resize corrupted images, providing a user-friendly interface for resizing images while preserving aspect ratios. Additionally, efforts were made to convert Python scripts into executable files, enhancing accessibility and

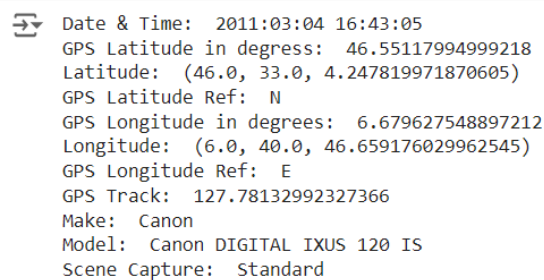
usability. Examples of resized images and their comparison before and after resizing were analyzed to assess the effectiveness of the resizing process and its impact on image quality.

CHAPTER 4: RESULTS AND ANALYSIS

This chapter presents the results obtained from the implementation of various projects during the internship and provides an analysis of these results.

Metadata Extraction Results:

The metadata extraction process yielded promising results, with metadata successfully extracted from a variety of image formats, including JPEG, PNG, and TIFF. The Python scripts developed for metadata extraction proved to be efficient and reliable, allowing for the extraction of essential attributes such as image dimensions, geo location, and creation date. The extracted metadata provided valuable insights into the characteristics of the image data, facilitating better organization and management of geospatial datasets.

A screenshot of a metadata extraction tool's output. It shows a list of key-value pairs for various metadata fields. The fields include Date & Time, GPS Latitude in degrees, Latitude, GPS Latitude Ref, GPS Longitude in degrees, Longitude, GPS Longitude Ref, GPS Track, Make, Model, and Scene Capture. The values are numerical and text-based, representing geospatial and camera data.

```
↔ Date & Time: 2011:03:04 16:43:05
GPS Latitude in degrees: 46.55117994999218
Latitude: (46.0, 33.0, 4.247819971870605)
GPS Latitude Ref: N
GPS Longitude in degrees: 6.679627548897212
Longitude: (6.0, 40.0, 46.659176029962545)
GPS Longitude Ref: E
GPS Track: 127.78132992327366
Make: Canon
Model: Canon DIGITAL IXUS 120 IS
Scene Capture: Standard
```

Fig 4.1: Result of Metadata extraction

Video Processing Outcomes:

The video processing tasks resulted in significant improvements in data usability and analysis. The extraction of individual frames from videos enabled frame-by-frame analysis, leading to deeper insights into temporal patterns and trends. Extracted video frames were analyzed to assess the quality and accuracy of the processing methods.

Geospatial Mapping Analysis with Leaflet:

This subsection delves into the analysis of geospatial mapping outcomes facilitated by Leaflet integration. It explores how Leaflet was instrumental in visualizing spatial distributions,



Fig 4.3: Result of Model training

Image Resizing and Corruption Handling Evaluation:

The image resizing and corruption handling processes were evaluated based on the quality and usability of the resized images. The Tkinter application developed for image resizing proved to be intuitive and user-friendly, allowing for easy resizing of images while preserving aspect ratios. Additionally, the conversion of Python scripts into executable files improved accessibility and usability, enabling non-technical users to utilize the resizing functionality. Examples of resized images were assessed to ensure that the resizing process did not degrade image quality or introduce artifacts.

CHAPTER 5: CONCLUSION

My internship at Magnasoft Consulting India (P) Ltd. has been a transformative experience, providing me with invaluable insights, skills, and opportunities for growth in the dynamic field of geospatial technology. Throughout this journey, I have had the privilege to work on diverse projects spanning image processing, machine learning, and geospatial mapping, each contributing to my professional development in unique ways.

As I conclude this internship report, I reflect on the knowledge gained, the challenges overcome, and the contributions made during my tenure at Magnasoft. From developing geospatial data processing pipelines to implementing machine learning models for object detection, each project has not only honed my technical expertise but also deepened my understanding of real-world applications of technology.

Moreover, this internship has provided me with invaluable lessons in project management, teamwork, and communication. Collaborating with talented professionals and engaging in cross-functional teams has broadened my perspective and enhanced my ability to work effectively in diverse environments.

Looking ahead, I am confident that the skills and experiences gained during this internship will serve as a solid foundation for my future endeavors. I am grateful to Magnasoft Consulting India (P) Ltd. for providing me with this enriching opportunity and to all those who have supported and guided me along the way.

In conclusion, this internship has been a journey of growth, learning, and discovery, and I am excited to apply the knowledge and skills acquired here to make meaningful contributions in my future career endeavors.

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ANNEXURE-1

LEARNING OUTCOMES

During my internship at Magnasoft Consulting India (P) Ltd., I acquired valuable knowledge and skills that have significantly contributed to my professional development. The following learning outcomes highlight the key insights gained from this experience:

- Advanced proficiency in Python programming and utilization of libraries such as PIL, OpenCV, TensorFlow, and Keras.
- Comprehensive understanding and application of geospatial technologies, including GIS, remote sensing, and mapping tools.
- Knowledge and implementation of machine learning algorithms for tasks such as object detection, classification, and segmentation.
- Efficient project management skills encompassing planning, execution, and monitoring of multiple projects.
- Effective communication and collaboration with cross-functional teams for project success.
- Strong problem-solving abilities and innovation in developing novel solutions to complex challenges.

ANNEXURE-2

DAILY DIARY

Week	Duration Start date – End date (DD/MM/YY) - (DD/MM/YY)	Progress of Internship/ Project
Week - 1	15/2/2024-21/2/2024	Develop Python scripts
Week - 2	22/2/2024-28/2/2024	Learn about machine learning models
Week - 3	29/2/2024-6/3/2024	Learn about machine learning models
Week - 4	7/3/2024-13/3/2024	Data Processing
Week - 5	14/3/2024-20/3/2024	Environment setup
Week - 6	21/3/2024-27/3/2024	Model implementation and training
Week - 7	28/3/2024-3/4/2024	Database creation using PostGre
Week - 8	4/4/2024-10/4/2024	Develop exe file using Tkinter
Week - 9	11/4/2024-17/4/2024	Develop routing algorithm using Leaflet
Week - 10	18/4/2024-24/4/2024	Model training
Week - 11	25/4/2024-1/5/2024	Optimize model
Week - 12	2/5/2024-8/5/2024	Dasboard design

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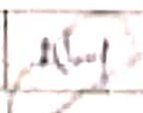
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ANNEXURE-3A

MPR-1

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CONTINUOUSLY PROGRESS REPORT DEVELOPMENT INDICATORS/COMPETENCY MEASUREMENT

Name of Student	Marking Scheme		Assessment By	Date of Report	
	Maximum	Obtained		From	To
Department	Mechanics & Computing		From	To	
Subsidiary Department	Department of Computing Softw. Engg. Lab		Date Document	11/01/2014 - 11/06/2014	
Criteria	Pass	Average	Good	Very Good	Excellent
Proficiency/Level of completion of assigned work				✓	
Learning capacity/Knowledge upgradation				✓	
Diligence/Quality of work				✓	
Behavior/Thought/Team work				✓	
Interest/Hard work				✓	
Comments on nature of work done/Work Type	Your efforts have significantly contributed to change laboratory practices and your expertise in this area has been remarkable in the team. Keep it up!				
OVERALL GRADE/Level	A++				
Name of Instructor/Supervisor/ Mentor	Dr. K. Kishore				
Name of Internal Assessor/ Mentor					
Recording Date 11/01/2014	Name of Faculty Mentor	Dr. Anil Kumar	Signature		

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ANNEXURE-3B

MPR-2

MADHAV INSTITUTE OF TECHNOLOGY & SCIENCE, GWALIOR
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ACADEMIC PROGRAMS REPORT FROM INDUSTRY/COMMITTEE MEMBER

Name of Institute	Eligible Degree		Examination No.	Semester/Year	
	Year	Semester		Year	Semester
Department	Mathematics & Computing		100	4 th Semester 2023-24	
Subject/Experiments	Management Consulting Index Pro List		100/1000000	2023/24 - 100/1000000	
Comments	Fair	Average	Good	Very Good	Excellent
Preparation/Quality completion of assigned work					✓
Learning supports/Knowledge upgradation				✓	
Performance/Quality of work				✓	
Adherence/Disruption/Time work				✓	
Inventory/Used work				✓	
Comments on areas of work done from Top	3-4 case studies were significantly considered as change direction project and your expertise in this area has been invaluable to the team. Keep it up.				
OVERALL GRADE/Rate	B++				
Name of Industry/Company/Institute	H. L. K. S. S.				
Name of Industry/Company/Institute & Member	[Redacted]				
Reporting Date	21/06/2024	Name of Faculty Member	Dr. Arun Kumar Rao	Signature	[Signature]

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ANNEXURE-3C

MPR-3

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(A Deemed to be University - Autonomous Institute affiliated to DPUV Bhopal)
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SEMESTER WISE PROGRAM REPORT AND PERFORMANCE REPORT

Name of Student	Semester/Topic		Registration No.	SEMESTER STUDY	
	Year	Topic		Very Good	Good
Department	Mechanics & Computing		Roll No.	4	January
Subject/Topic	Mechanics & Computing		Registration No.	11111111	11111111
College	Year	Average	Grade	Very Good	Good
Practical/Assignments/Completion of assigned work					✓
Learning capacity/Understanding of problems				✓	
Performance/Quality of work				✓	
Behavior/Regular Attendance					✓
Library/Study Hours					✓
Comments on nature of work done/How Topics	None of it				
OVERALL GRADE/Level	B-2				
Name of Institute/Examiner/Institute	M.I.T.S.				
Signature of Institute/Examiner/Institute					
Recording Date 08/01/2024	Name of Faculty/Dr. Anil Kumar		Signature	Signature	Signature

OFFER LETTER

