Designing of Heat Exchanger & Tube pitch.

Internship Report

Submitted for the partial fulfillment of the degree of

Bachelor of Technology

In

Chemical Engineering

Submitted By

Khushi Dandotiya

0901CM201021

UNDER THE SUPERVISION AND GUIDANCE OF

Anish P. Jacob

Coordinator and Assistant Professor

Department of Chemical Engineering

MADHAV INSTITUTE OF TECHNOLOGY & SCIENCE, GWALIOR (M.P.), INDIA
माधव प्रौद्योगिकी एवं विज्ञान संस्थान, ग्वालियर (म.प्र.), भारत
Deemed to be University
(Declared under Distinct Category by Ministry of Education, Government of India)
NAAC ACCREDITED WITH A++ GRADE

Jan-May 2024

INTERNSHIP CERTIFICATE

Myriadly

[illegible]

CERTIFICATE

Date: 20-05-2024

To whomsoever it may concern,

This is to certify that Ms. Khushi dandotiya, B.Tech. in Chemical Engineering (4th year) from Madhav Institute of Technology & Science, Gwalior has undergone 4 months unpaid Internship in our organization from 15-01-2024 to 15-05-2024

During his Internship, she completed the project titled "Designing & Costing of Heat Exchanger " with compassion and diligence.

We wish Ms. Khushi success in all his future endeavours as she progresses in his professional career.

For Myriadly Engineering & Business Solutions

Authorized signatory

Email: [illegible] Contact No: [illegible] Website: [illegible]

DECLARATION BY THE CANDIDATE

I hereby declare that the work entitled "**Designing of heat exchanger & Tube pitch.**

"is my work, conducted under the supervision of **Prof. Anish P. Jacob, Coordinator and Assistant Professor** , during the session Jan-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.

Khushi Dandotiya

0901CM201021

Date: 24/05/24

Place: Gwalior

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

Guided By:

24/05/24

Anish P. Jacob
Coordinator and Assistant Professor
Department of Chemical Engineering
MITS, Gwalior

Departmental Project Coordinator

24/05/24

Prof. Shivangi Sharma
Assistant Professor
Department of Chemical Engineering
MITS, Gwalior

Approved by HoD

24/05/24

Prof. Anish P. Jacob
Coordinator and Assistant Professor
Department of Chemical Engineering
MITS, Gwalior

Chemical Engineering
MITS, Gwalior

Plagiarism Check Certificate

This is to certify that I/we, a student of B.Tech. in **Chemical Engineering Department** have checked my complete report entitled **"Designing of Heat Exchanger & Tube Pitch."** for similarity/plagiarism using the "Turnitin" software available in the institute.

This is to certify that the similarity in my report is found to be 17% which is within the specified limit (20%).

The full plagiarism report along with the summary is enclosed.

Khushi Dandotiya
0901CM201021

Checked & Approved By:

24/03/24

Anish P. Jacob
Turnitin cordinator
Department of Chemical Engineering
MITS, Gwalior

ABSTRACT

This internship report analyze how designing and manufacturing processes interact dynamically in today industrial environment. Setting out to explore the complex relationship that exists between innovation and productivity, this paper summarises my time interning at MYRIADLY ENGINEERING & BUSINESS SOLUTION PVT. LIMITED, a major participant in the Manufacturing and Designing of Pharmaceutical & Chemical equipment Market. During the internship, a lot of focus was on helping interns see how Important it is for design to influence manufacturing processes and vice versa. The study explains the complex processes involved in bridging the gap between creative design concepts and realistic manufacturing viability, from conception to implementation. This internship report highlights the beneficial relationship between design and manufacturing processes, highlighting their combined influence on promoting innovation and competitiveness in the modern industrial environment. It provides an in-depth perspective on the complicated relationships between creativity and execution that will shape the direction of product creation in the future through a combination of theoretical study and real-world applications.

Keywords : Designing , Manufacturing , Innovation, Execution, Competitiveness

ACKNOWLEDGEMENT

This semester internship has proven to be crucial to my career. I am very grateful to my institute, **“Madhav Institute of Technology & Science”** to permit me to continued my interdisciplinary internship as a curriculum requirement, agreed by the academic council of institute. I protract my appreciation to the Director of the institute, **Dr. R.K Pandit** and Dean Academics**, Dr. Manjaree Pandit** for the, Guidance and Co-operation are valuable for fulfilling and furnishing any kind of work. Similarly, I am dearly thankful to the Management for granting me this prestigious opportunity to learn from the Field Knowledge based on the theoretical aspects and also for guiding me during the ongoing training Period. I am sincerely grateful to my faculty mentors. I am thankful to the guidance of **Anish P. Jacob**, Assistant Professor, Department of Chemical Engineering, for the persisted support and close mentoring Throughout the internship. I appreciates all the faculty and staff of the department. And I am Grateful to **Mr. Rakesh Agarwal** as an industry mentor who helped me a lot to get interact with the Industry for guiding me throughout the internship.

Khushi Dandotiya

0901CM201021

CONTENT

Table of Contents

ACRONYMS

- IC: Inter cooler
- CE: Combustion engines
- Pvt: Private
- Ltd: Limited
- GMP: Good manufacturing practice
- CAD: Computer aided design

NOMENCLATURE

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1: INTRODUCTION

A heat exchanger is an instrument which is the process of heat exchanges between the two fluids that are at the two different temperatures. . The topic shows about the specification which has impact the accomplishment of a heat exchanger and discuss the Comparative for the design or the section of the performance of an existing heat exchanger. In shell-and-tube heat exchangers, two fluids at different temperatures pass through distinct regions. One fluid circulates inside the tubes, while the other flows outside the tubes within the surrounding shell. Baffles are employed to support the tubes, direct the flow of fluid inside the tubes in a somewhat natural manner, and enhance the turbulence of the fluid within the shell. Numerous types of baffles exist for this purpose.with choices regarding spacing, and geometry depending on the permissible pressure drop on the shell side, the need for tube support , and the potential for flow induced vibrations. Variations in exchangers are primarily due to differences in flow configurations and construction details. It comprises of series of tubes that contain fluid that must be either heated or cooled. A second fluid flows over the tubes that can be either separated if absorb the heat required. A set of tubes is called the tube bundle which are made of various types of tubes: plain, finned, etc. heat exchangers are commonly used for higher- pressure applications. It is because the shell and tube heat exchangers are rugged due to it’s shape.

CHAPTER 2: LITERATURE SURVEY

Myriadly Engineering & Business Solutions Pvt. Ltd. is dedicated to providing engineering and business solution to the chemical and pharmaceutical industry. Their mission is to provide the pharmaceutical and chemical industry with technical solutions to the best of their knowledge. All their products are customized according to the customer& requirements. They use GMP practices to manufacture their products. The company unwavering commitment is to provide cutting-edge design solutions that specifically address The unique needs of the pharmaceutical and chemical industries, leveraging their expertise and knowledge. Myriadly Engineering and Solutions Pvt. with a strong emphasis on customization. Ltd. ensuring that all their products are carefully tailored to the specific requirements of each client, resulting in optimal results. One of the key pillars of the company's operation is their adherence to Good Manufacturing Practice (GMP). By strictly following these industry standards, Myriadly Engineering & Solutions Pvt. Ltd. maintains the highest levels of quality, safety, and reliability in the manufacturing of their products. The implementation of GMP practices is a testament to the company's dedication to providing excellence and upholding industry best practices. Their goal is to offer the industries the best possible services. Indian and international standards are followed in the manufacturing of our goods. Thanks to the gratitude and goodwill that clients from all across India have shown for the company, it has seen the expected growth over the previous three years. This company is working really hard to meet and exceed the needs and desires of its customers. At different phases, the goods produced by Myriadly Engineering & Business Solution Pvt. Ltd. go through a thorough testing and quality assurance technique.

Raw material Inspection: A thorough inspection of the new materials is conducted according to the specified requirements and predetermined schedules.

Inspection during production: Inspections are conducted at various stages of the production process to guarantee the caliber of the fabrication, galvanizing, machining, and moldings. This guarantees high-quality output and reduces rejection rates**.**

CHAPTER 3: COMPANY PROFILE

Vision: Myriadly Engineering & Business Solution Pvt. Ltd. aspires to become a global leader in providing comprehensive, easily accessible industrial solutions with an unmatched level of excellence. Having become a one-stop shop for all things industrial, their ultimate objective is to become a name that people associate with excellence in terms of dependability, convenience, and quality. They want to be the first company that companies throughout the world turn to when they need dependable, top-notch industrial solutions.

Mission: Myriadly Engineering & Business Solution Pvt. Ltd. mission is to serve as a liaison between chemical and pharmaceutical firms and the service sectors that support them. By offering all-inclusive solutions and services, they aim to promote smooth collaboration and improve efficiency in various industries. Myriadly Engineering & Business Solution Pvt. Ltd. wants to support the expansion and improvement of the industry as a whole while offering worthwhile chances for aspirant professionals. The company also hopes to encourage the development of young talent by providing opportunities for them to work as freelancers.

Pre-dispatch inspection: After items are assembled or produced, a thorough examination is carried out before shipping to ensure that all attachments fit correctly. This stage guarantees that the finished product satisfies the relevant requirements. Drawings & Test Certificates: After items are assembled or produced, a thorough examination is carried out before shipping to ensure that all attachments fit correctly. This stage guarantees that the finished product satisfies the relevant requirements.

The company& tagline is affordable solutions without sacrificing quality." Actually, every one of our products which include heat exchangers with hastelloy coating, glove boxes, lab scale reactors, colloid coating, and lab scale reactors meets international standards and is put through a rigorous quality inspection process before being delivered to the final consumer. The production department oversees the actual manufacturing process of condensers and heat exchangers. Skilled technicians and engineers work here to fabricate components, assemble units, and perform quality checks. They follow engineering drawings and specifications to ensure that each unit meets quality standards and customer requirements.

CHAPTER 4 :PROBLEM FORMULATION

Ina Kerosene – crude oil exchanger. 43,800 lb/hr of 42 degree API kerosene exits the Bottom of a distillation column at 390 degree fahrenheit and is cooled to 200 degree fahrenheit by 149,000lb/hr of 34 degree API Mid -continent crude oil ,comes which is stored at 100 degree fahrenheit and heated to 170 degree fahrenheit. A 10 psi pressure drop is acceptable for both streams, and the Available exchanger for this process has a 21.25 in Internal diameter, containing 158 tubes with a 1- inch outer diameter, 13 BWG each 16 feet long , arranged in a 1.25 inch square pitch. The bundle has arranged in four passes, with baffles spaced 5 inch aprat. , what is the Clean overall heat transfer coefficient?

CHAPTER 5 :PROPOSED METHODLOGY

A heat exchanger should be created by the LMTD where inlet and outlet conditions are declared. Where the problem is to resolve the inlet and outlet temperatures of an appropriate heat exchanger, the analysis is accomplished more easily while using a method depending on efficiency of heat exchanger and number of transfer units (NTU). In designing of shell and tube heat exchangers, in examining the question both observationally and theoretically, distinguished the potential profitableness of specific representation of LMTD Correction factors in elaborating computerized packages for heat exchangers designs. Tinker et al has recommended a schematic flow pattern, that divides the shell–side flow into a number of severally streams. Tinkers model has formed the foundation for the “stream analysis method”, which uses a highly redundant approach and is particularly suitable for computer calculations rather than hand calculations. This method incorporates correction factors for heat transfer and pressure drop correlations. Heat transfer is achieved through three main mechanisms: conduction, convection and radiation. Heat exchangers operate based on conduction and convection.While radiation does occur in many processes, it’s contribution in most heat exchangers is minimal compared to the other two methods. Conduction takes place as heat from the hot fluid passes through the inner pipe wall. To improve heat transfer, the inner pipe wall should be thin and made of a highly conductive material.

Chapter 6: Results & Discussion

The performance analysis of the heat exchanger reveals significant findings. The heat exchanger, designed with a series of tubes through which the primary fluid flows, exhibits efficient heat transfer capabilities when subjected to varying operating conditions. The second fluid, flowing outside these tubes within the shell, successfully absorbs or dissipates heat, achieving the desired temperature changes. The inclusion of baffles has been particularly effective in enhancing the turbulence of the shell-side fluid, thereby improving heat transfer rates. Different baffle configurations and spacings were tested, showing that optimal spacing is crucial for balancing pressure drops and maximizing heat transfer efficiency.

In high-pressure applications, the robust design of the shell-and-tube heat exchanger proved advantageous. The use of various tube types, such as plain and finned tubes, demonstrated that tube geometry significantly impacts thermal performance. The rugged construction of these exchangers allows them to withstand substantial pressure variations, making them ideal for industrial applications. Computer simulations based on Tinker’s model and the Stream Analysis Method highlighted the accuracy of heat transfer and pressure drop predictions. The computational approach was found to be more effective than manual calculations, particularly in handling complex configurations and multiple variables. Overall, the study confirms that the shell-and-tube heat exchanger is a versatile and efficient solution for thermal management in various industrial processes. The results underscore the importance of proper design, including

Chapter 7: Conclusion

The following conclusions are achieved from the transfer analysis of shell and tube heat exchanger for three several fluid combinations (water-steam, CO2-steam and SO2-steam) using qern's method. Validations for on tube side of water is in comparison with a digression . From the data achieved and arrived this is found as in In the study, steam was used on the shell side while CO2 and SO2 were used on the tube side of the heat exchanger. It was observed that the Nusselt numbers increased significantly for the SO2-steam combination compared to the CO2-steam combination, although the friction factor remained nearly the same for both combinations. Shell-and-tube heat exchangers are highly versatile and efficient, making them suitable for a wide range of industrial applications. Their unique design allows for high heat transfer efficiency, making them an ideal choice for critical heat exchange processes. Industrial manufacturers provide various types of shell-and-tube heat exchangers with customization options to meet specific application needs. Additionally, their ease of maintenance and cleaning extends their lifespan and improves efficiency. In summary, the design of shell-and-tube heat exchangers is flexible and efficient, offering numerous advantages that make them a valuable investment for companies aiming to enhance their heat transfer processes.

CHAPTER 8.1: ACHIEVED OUTCOMES

- Design the compatible Heat Exchanger and Tube Pitch
- Solved any Heat Exchanger Problems .
- Worked efficiently with Excel includes plotting the graph.

CHAPTER 8.2: SOCIETAL RELEVANCE

Heat exchangers are important in different industries and applications where efficiency of transfering of heat is essential. Heat transfer has major applications to the functioning of numerous devices and systems. The topic represents the specification that impacts the performance of a heat exchanger and discusses the Comparative for the design of a heat exchanger or the projection of the performance which is existing heat exchanger. Heat exchangers required everyday maintaining to function at higher efficiency and normally requires a rigorous overall schedule is essential, with much effort focused on The impact of fouling, where solids like foreign particles or precipitates build up on heat exchanger surfaces, necessitates various maintenance actions. These can range from simple preventive measures like flushing to more extensive repairs, such as removing the tube bundle from the heat exchanger shell for cleaning. Designing heat exchanger configurations should account for this downtime, for instance, by installing parallel trains that enable one heat exchanger to undergo cleaning while the plant continues operating. Given that many heat exchangers handle hazardous fluids at high pressures and temperatures, rigorous process safety measures in the design are essential to prevent personal risks and system failures.

CHAPTER 9: REFERENCES

1. Kern, Process Heat Transfer, Mc Graw – Hill

2. Roetzel and Nicole, Mean Temperature Difference for Heat Exchanger Design – A General Approximate Explicit Equation, Journal of Heat Transfer, Vol. 97, pp 5-8, 1975.

3. Tinker, Shell Side Characteristic of Shell Tube Heat Exchangers, Parts I, II &III, in: Proceedings of General Discussion on Heat transfer, Institute of Mechanical Engineers and American Society of Mechanical Engineers, Vol 10 pp. 820-826, 1951.

4. Saunders, Heat Exchangers, John Wiley & Sons

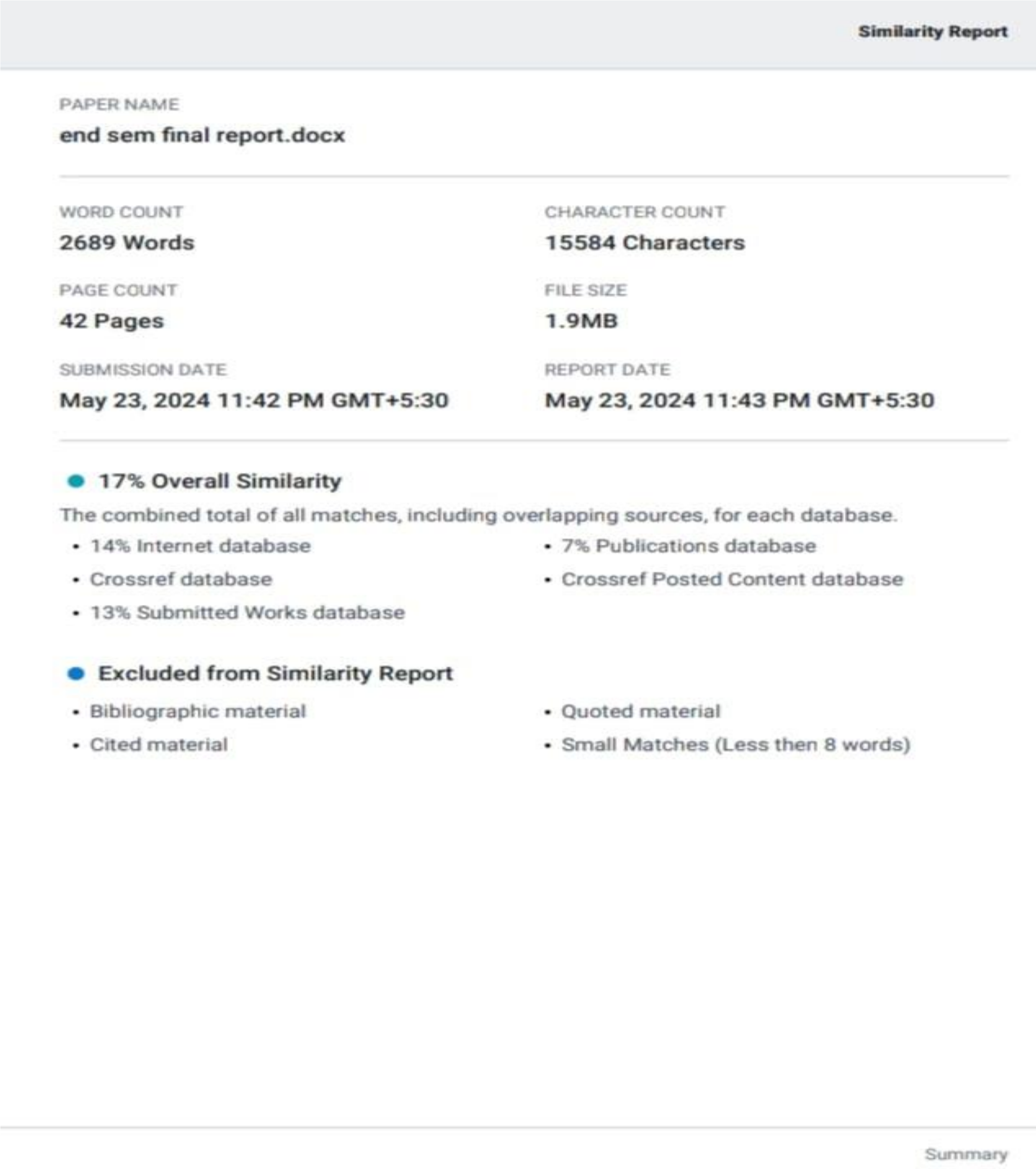
5. Wills and Johnston, A New and Accurate Hand Calculation Method for Shell-Side Pressure Drop and Flow Distribution, in: 22nd National Heat Transfer Conference, and 36 pp. 256-262, 1990.

6. Chen su and Do Hyung Choi Analysis of Heat Transfer performance of Shell and Tube Heat Exchanger, International Journal of Heat and Mass transfer, Vol. 55, pp. 1496-1504,1993.

7. Liljana Markovska and Vera Mesko Optimum Design of Shell and Tube Heat Bulletin of the Chemists and Technologies of Macedonia, Vol. 15, No. 1, pp. 39 - 44 (1996).

8. G.V.Srinivasa Rao, Dr. C. J. Rao, Dr. N. haribabu Heat Transfer Analysis on Shell and Tube Heat Exchangers, International Journal of Research in Aeronautical and Mechanical Engineering, vol.2 issue.1, January 2014. Pgs: 11-26

TURNITIN PLAGIARISM REPORT



Similarity Report

PAPER NAME

end sem final report.docx

WORD COUNT **2689 Words**	CHARACTER COUNT **15584 Characters**
PAGE COUNT **42 Pages**	FILE SIZE **1.9MB**
SUBMISSION DATE **May 23, 2024 11:42 PM GMT+5:30**	REPORT DATE **May 23, 2024 11:43 PM GMT+5:30**

● **17% Overall Similarity**

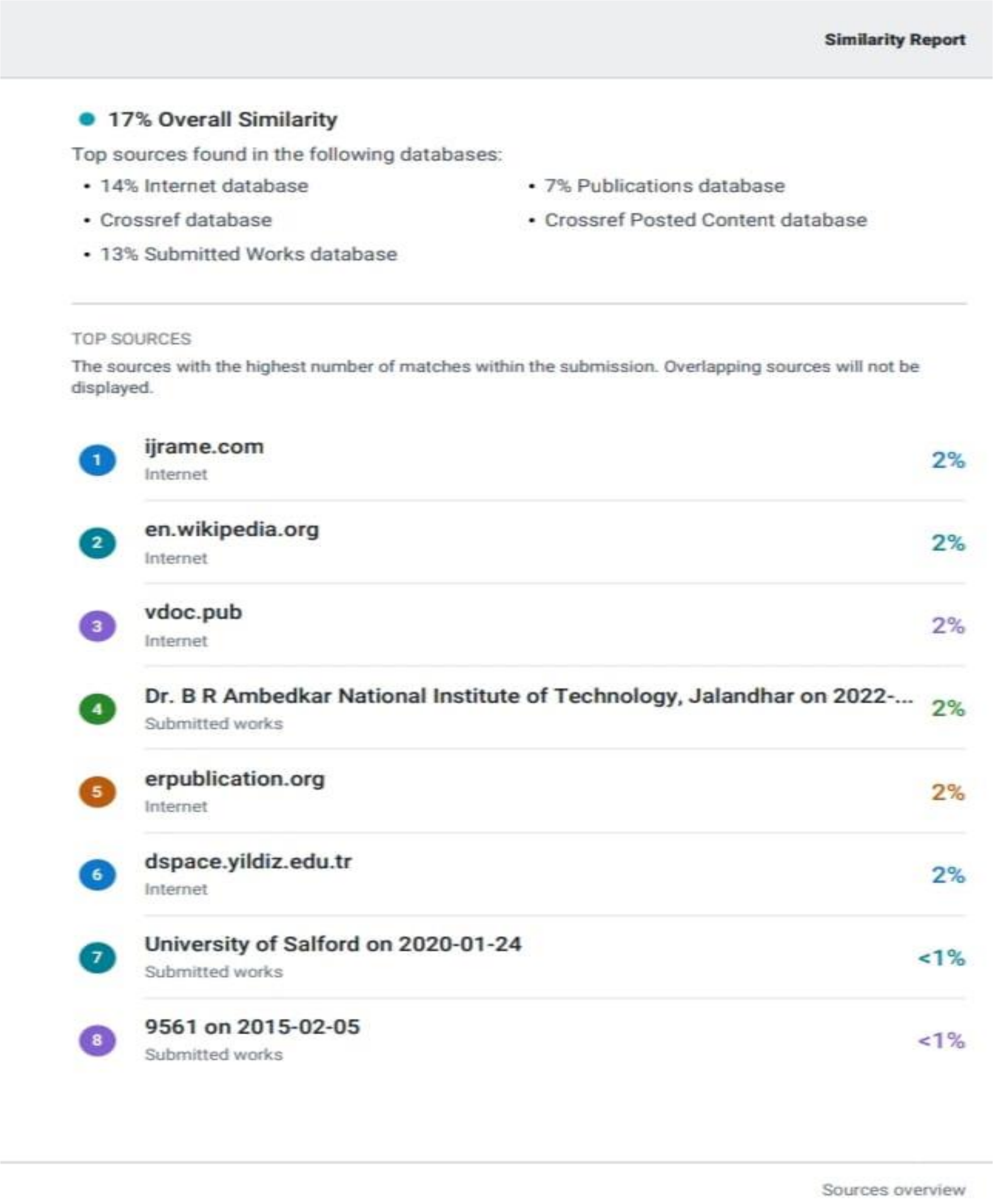
The combined total of all matches, including overlapping sources, for each database.

- 14% Internet database
- Crossref database
- 13% Submitted Works database
- 7% Publications database
- Crossref Posted Content database

● **Excluded from Similarity Report**

- Bibliographic material
- Cited material
- Quoted material
- Small Matches (Less then 8 words)

Summary



Similarity Report

● **17% Overall Similarity**

Top sources found in the following databases:

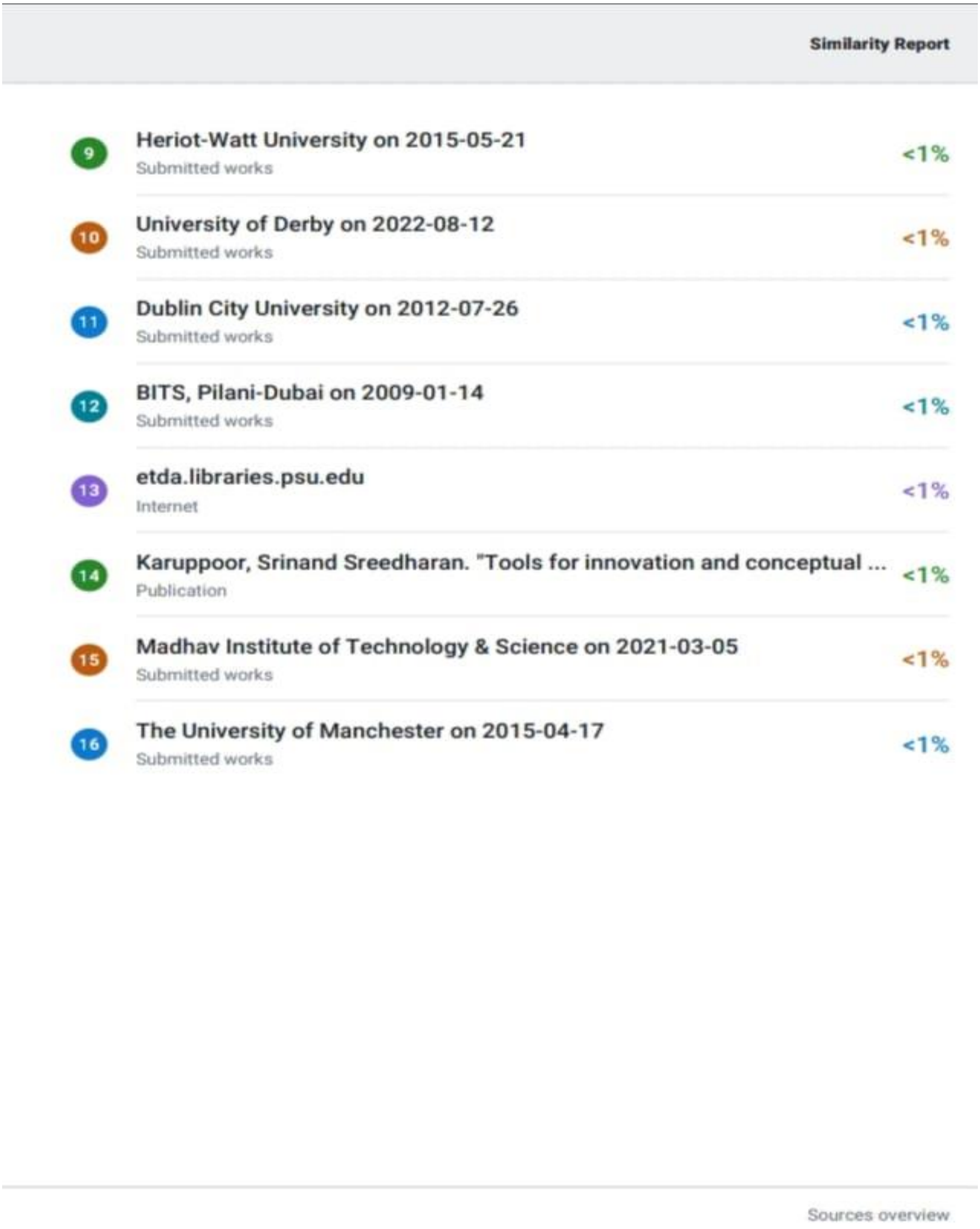
- 14% Internet database
- 7% Publications database
- Crossref database
- Crossref Posted Content database
- 13% Submitted Works database

TOP SOURCES

The sources with the highest number of matches within the submission. Overlapping sources will not be displayed.

1	**ijrame.com** Internet	2%
2	**en.wikipedia.org** Internet	2%
3	**vdoc.pub** Internet	2%
4	**Dr. B R Ambedkar National Institute of Technology, Jalandhar on 2022-...** Submitted works	2%
5	**erpublication.org** Internet	2%
6	**dspace.yildiz.edu.tr** Internet	2%
7	**University of Salford on 2020-01-24** Submitted works	<1%
8	**9561 on 2015-02-05** Submitted works	<1%

Sources overview

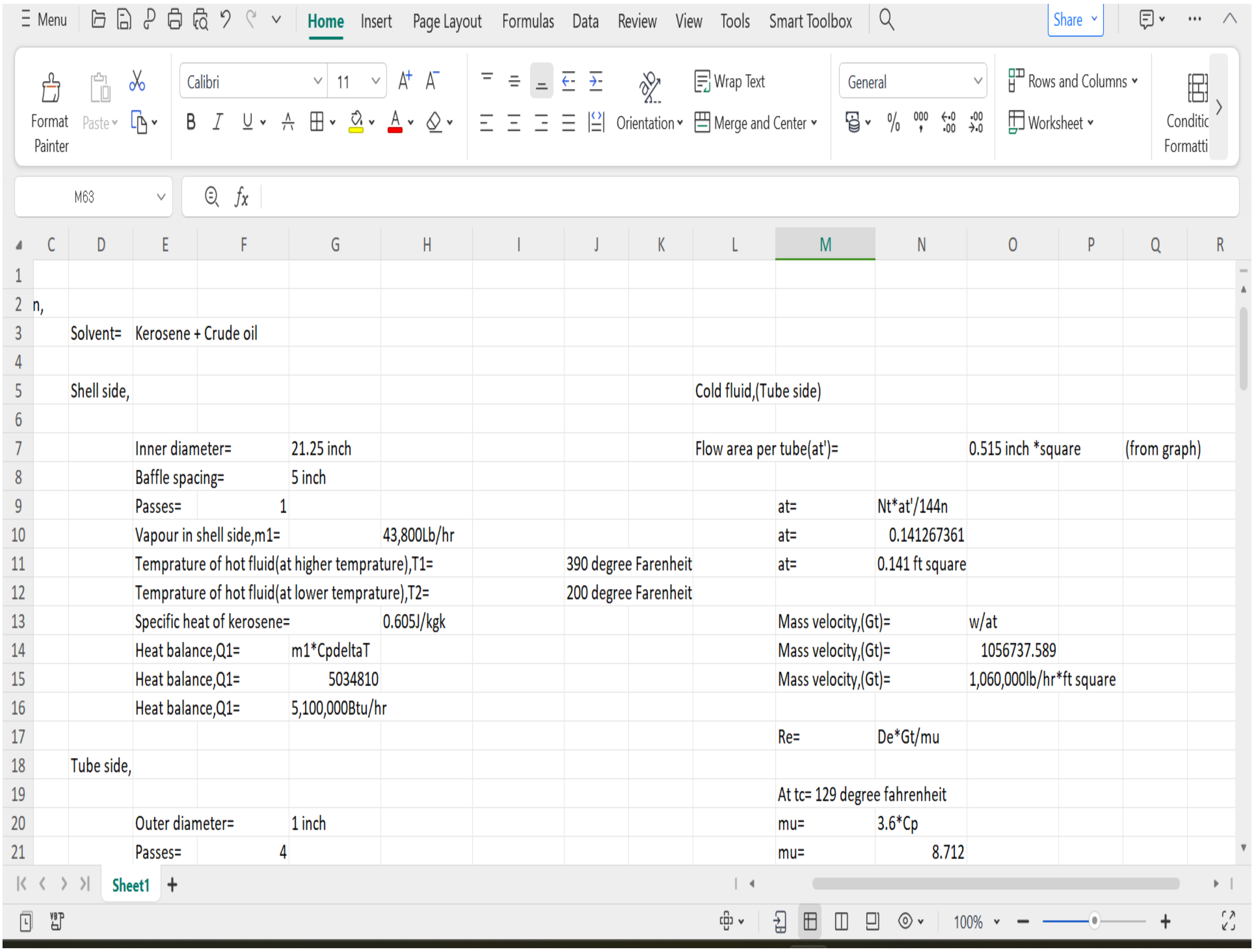


Similarity Report

9	**Heriot-Watt University on 2015-05-21** Submitted works	<1%
10	**University of Derby on 2022-08-12** Submitted works	<1%
11	**Dublin City University on 2012-07-26** Submitted works	<1%
12	**BITS, Pilani-Dubai on 2009-01-14** Submitted works	<1%
13	**etda.libraries.psu.edu** Internet	<1%
14	**Karuppoor, Srinand Sreedharan. "Tools for innovation and conceptual ...** Publication	<1%
15	**Madhav Institute of Technology & Science on 2021-03-05** Submitted works	<1%
16	**The University of Manchester on 2015-04-17** Submitted works	<1%

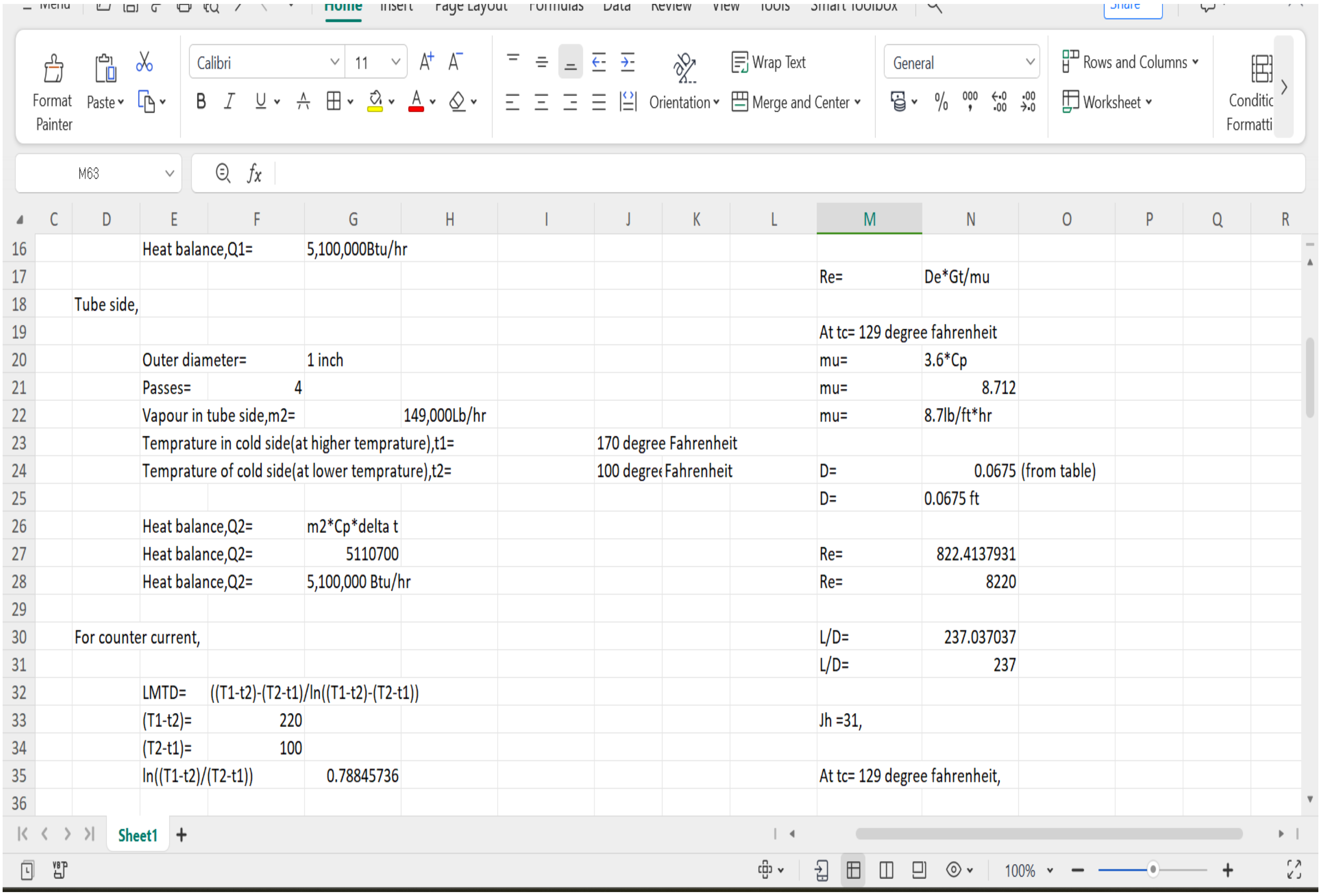
Sources overview

APPENDIX



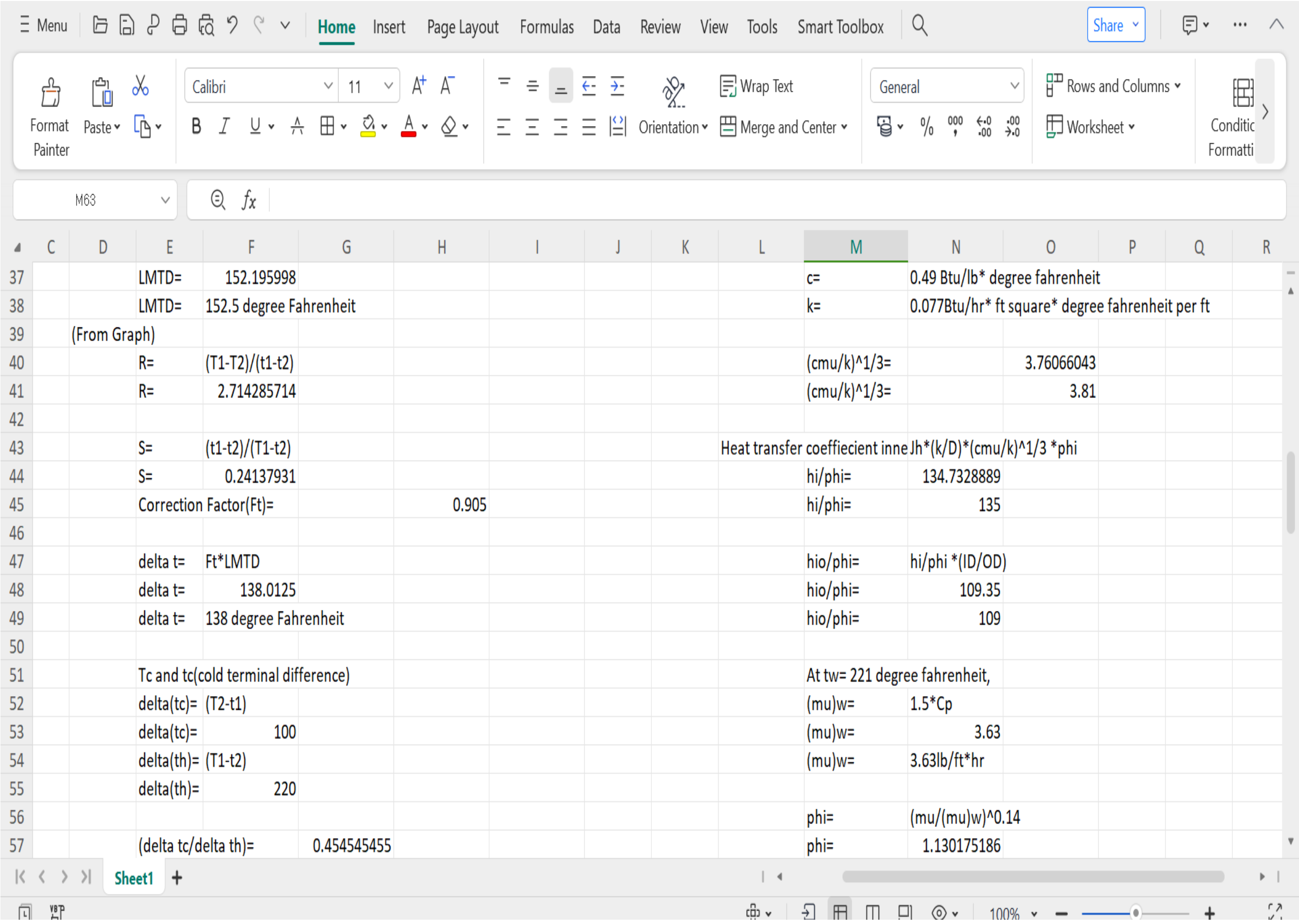
	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1																
2	n,															
3		Solvent=	Kerosene + Crude oil													
4																
5		Shell side,								Cold fluid,(Tube side)						
6																
7			Inner diameter=		21.25 inch					Flow area per tube(at')=			0.515 inch *square		(from graph)	
8			Baffle spacing=		5 inch											
9			Passes=	1							at=	Nt*at'/144n				
10			Vapour in shell side,m1=			43,800Lb/hr					at=	0.141267361				
11			Temprature of hot fluid(at higher temprature),T1=					390 degree Farenheit			at=	0.141 ft square				
12			Temprature of hot fluid(at lower temprature),T2=					200 degree Farenheit								
13			Specific heat of kerosene=			0.605J/kgk					Mass velocity,(Gt)=		w/at			
14			Heat balance,Q1=		m1*CpdeltaT						Mass velocity,(Gt)=		1056737.589			
15			Heat balance,Q1=		5034810						Mass velocity,(Gt)=		1,060,000lb/hr*ft square			
16			Heat balance,Q1=		5,100,000Btu/hr											
17											Re=	De*Gt/mu				
18		Tube side,														
19											At tc= 129 degree fahrenheit					
20			Outer diameter=		1 inch						mu=	3.6*Cp				
21			Passes=	4							mu=	8.712				

Fig.1.1: Heat Exchanger Problem (1)



	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
16			Heat balance,Q1=		5,100,000Btu/hr											
17											Re=	De*Gt/mu				
18		Tube side,														
19											At tc= 129 degree fahrenheit					
20			Outer diameter=		1 inch						mu=	3.6*Cp				
21			Passes=	4							mu=	8.712				
22			Vapour in tube side,m2=			149,000Lb/hr					mu=	8.7lb/ft*hr				
23			Temprature in cold side(at higher temprature),t1=					170 degree Fahrenheit								
24			Temprature of cold side(at lower temprature),t2=					100 degre	Fahrenheit		D=	0.0675	(from table)			
25											D=	0.0675 ft				
26			Heat balance,Q2=		m2*Cp*delta t											
27			Heat balance,Q2=		5110700						Re=	822.4137931				
28			Heat balance,Q2=		5,100,000 Btu/hr						Re=	8220				
29																
30		For counter current,									L/D=	237.037037				
31											L/D=	237				
32			LMTD=	((T1-t2)-(T2-t1)/ln((T1-t2)-(T2-t1))												
33			(T1-t2)=	220							Jh =31,					
34			(T2-t1)=	100												
35			ln((T1-t2)/(T2-t1))		0.78845736						At tc= 129 degree fahrenheit,					
36																

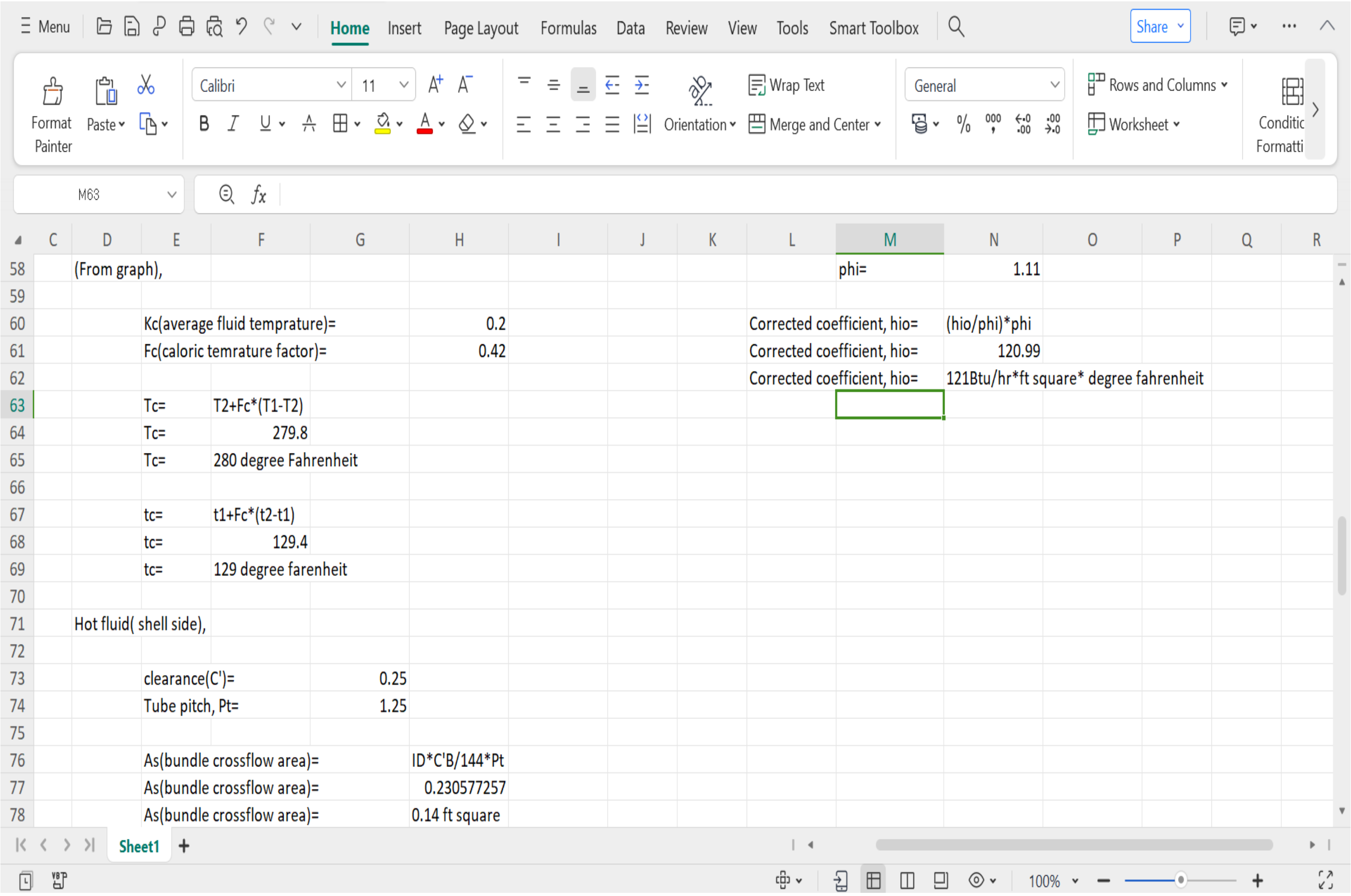
Fig.1.2: Heat Exchanger Problem (2)



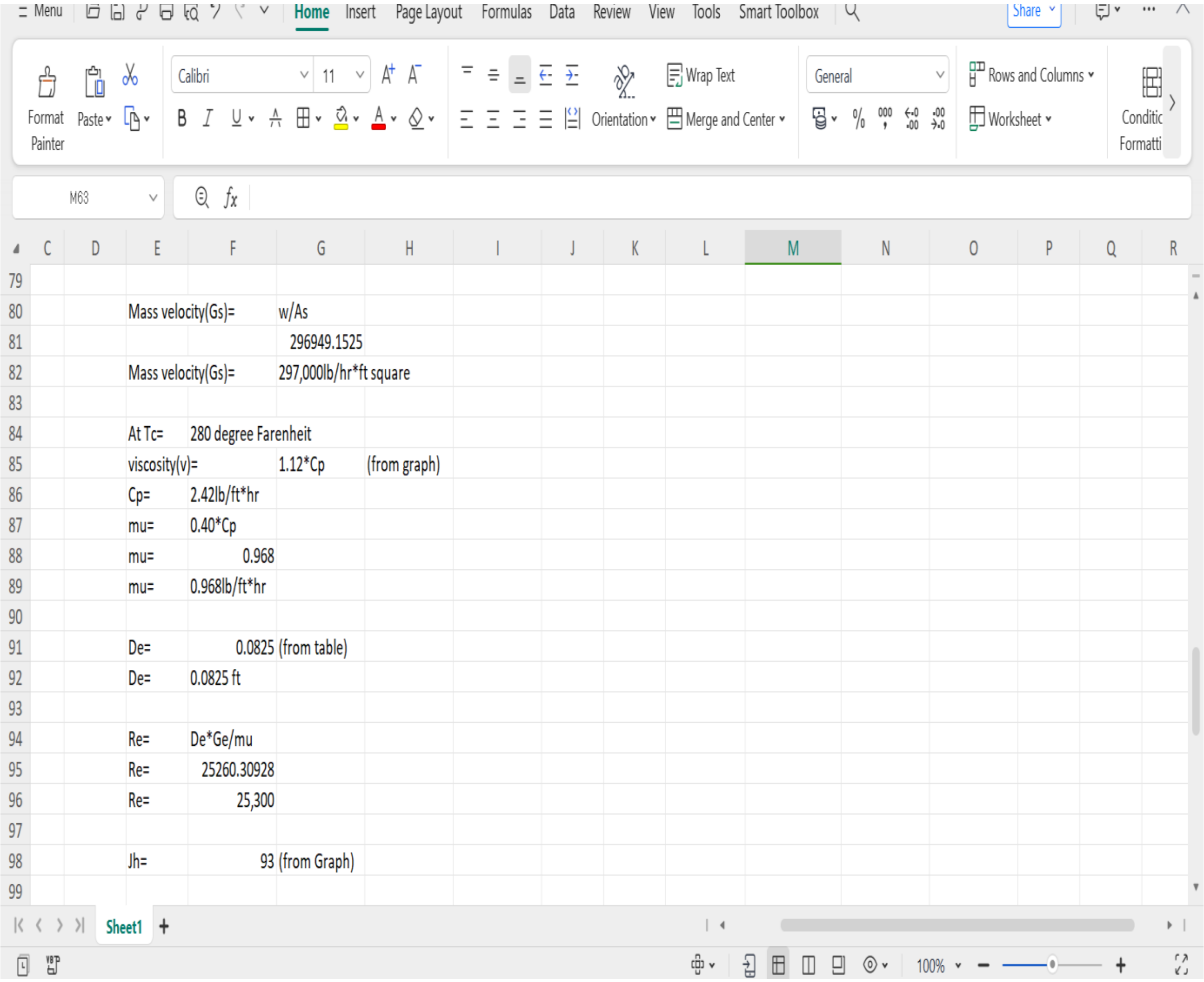
	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
37			LMTD=	152.195998							c=	0.49 Btu/lb* degree fahrenheit				
38			LMTD=	152.5 degree Fahrenheit							k=	0.077Btu/hr* ft square* degree fahrenheit per ft				
39		(From Graph)														
40			R=	(T1-T2)/(t1-t2)							(cmu/k)^1/3=		3.76066043			
41			R=	2.714285714							(cmu/k)^1/3=		3.81			
42																
43			S=	(t1-t2)/(T1-t2)						Heat transfer coeffiecient inne		Jh*(k/D)*(cmu/k)^1/3 *phi				
44			S=	0.24137931							hi/phi=	134.7328889				
45			Correction Factor(Ft)=			0.905					hi/phi=	135				
46																
47			delta t=	Ft*LMTD							hio/phi=	hi/phi *(ID/OD)				
48			delta t=	138.0125							hio/phi=	109.35				
49			delta t=	138 degree Fahrenheit							hio/phi=	109				
50																
51			Tc and tc(cold terminal difference)								At tw= 221 degree fahrenheit,					
52			delta(tc)=	(T2-t1)							(mu)w=	1.5*Cp				
53			delta(tc)=	100							(mu)w=	3.63				
54			delta(th)=	(T1-t2)							(mu)w=	3.63lb/ft*hr				
55			delta(th)=	220												
56											phi=	(mu/(mu)w)^0.14				
57			(delta tc/delta th)=		0.454545455						phi=	1.130175186				

Fig.1.3: **Heat Exchanger Problem (3)**

Fig 1.4: Heat Exchanger Problem (4)

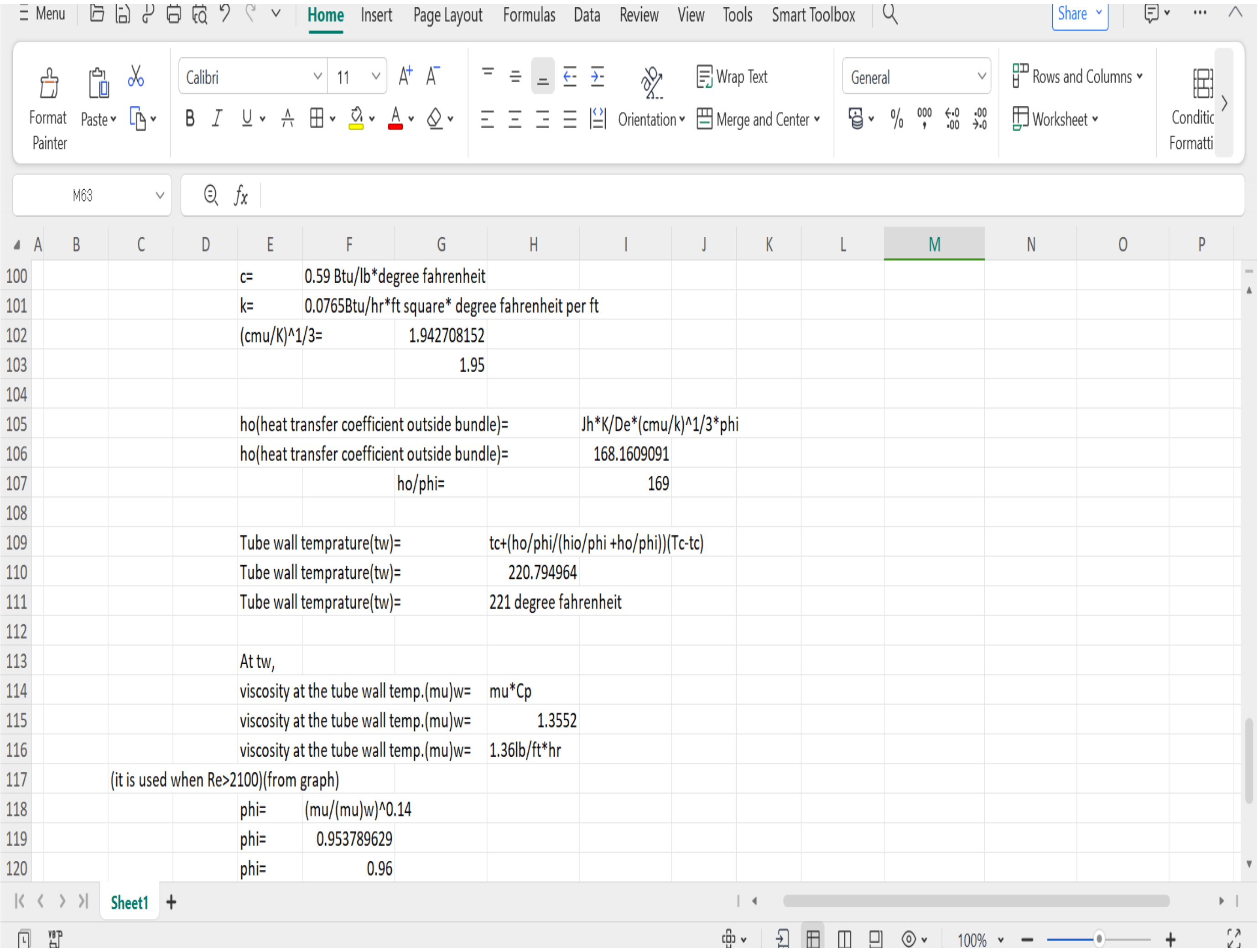


	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
58		(From graph),									phi=	1.11				
59																
60			Kc(average fluid temprature)=			0.2				Corrected coefficient, hio=		(hio/phi)*phi				
61			Fc(caloric temrature factor)=			0.42				Corrected coefficient, hio=		120.99				
62										Corrected coefficient, hio=		121Btu/hr*ft square* degree fahrenheit				
63			Tc=	T2+Fc*(T1-T2)												
64			Tc=	279.8												
65			Tc=	280 degree Fahrenheit												
66																
67			tc=	t1+Fc*(t2-t1)												
68			tc=	129.4												
69			tc=	129 degree farenheit												
70																
71		Hot fluid(shell side),														
72																
73			clearance(C')=		0.25											
74			Tube pitch, Pt=		1.25											
75																
76			As(bundle crossflow area)=			ID*C'B/144*Pt										
77			As(bundle crossflow area)=			0.230577257										
78			As(bundle crossflow area)=			0.14 ft square										



	C	D	E	F	G	H
79						
80			Mass velocity(Gs)=		w/As	
81					296949.1525	
82			Mass velocity(Gs)=		297,000lb/hr*ft square	
83						
84			At Tc=	280 degree Farenheit		
85			viscosity(v)=		1.12*Cp	(from graph)
86			Cp=	2.42lb/ft*hr		
87			mu=	0.40*Cp		
88			mu=	0.968		
89			mu=	0.968lb/ft*hr		
90						
91			De=	0.0825	(from table)	
92			De=	0.0825 ft		
93						
94			Re=	De*Ge/mu		
95			Re=	25260.30928		
96			Re=	25,300		
97						
98			Jh=	93	(from Graph)	
99						

Fig.1.5: Heat Exchanger Problem (5)



c= 0.59 Btu/lb*degree fahrenheit

k= 0.0765Btu/hr*ft square* degree fahrenheit per ft

(cmu/K)^1/3= 1.942708152

1.95

ho(heat transfer coefficient outside bundle)= Jh*K/De*(cmu/k)^1/3*phi

ho(heat transfer coefficient outside bundle)= 168.1609091

ho/phi= 169

Tube wall temprature(tw)= tc+(ho/phi/(hio/phi +ho/phi))(Tc-tc)

Tube wall temprature(tw)= 220.794964

Tube wall temprature(tw)= 221 degree fahrenheit

At tw,

viscosity at the tube wall temp.(mu)w= mu*Cp

viscosity at the tube wall temp.(mu)w= 1.3552

viscosity at the tube wall temp.(mu)w= 1.36lb/ft*hr

(it is used when Re>2100)(from graph)

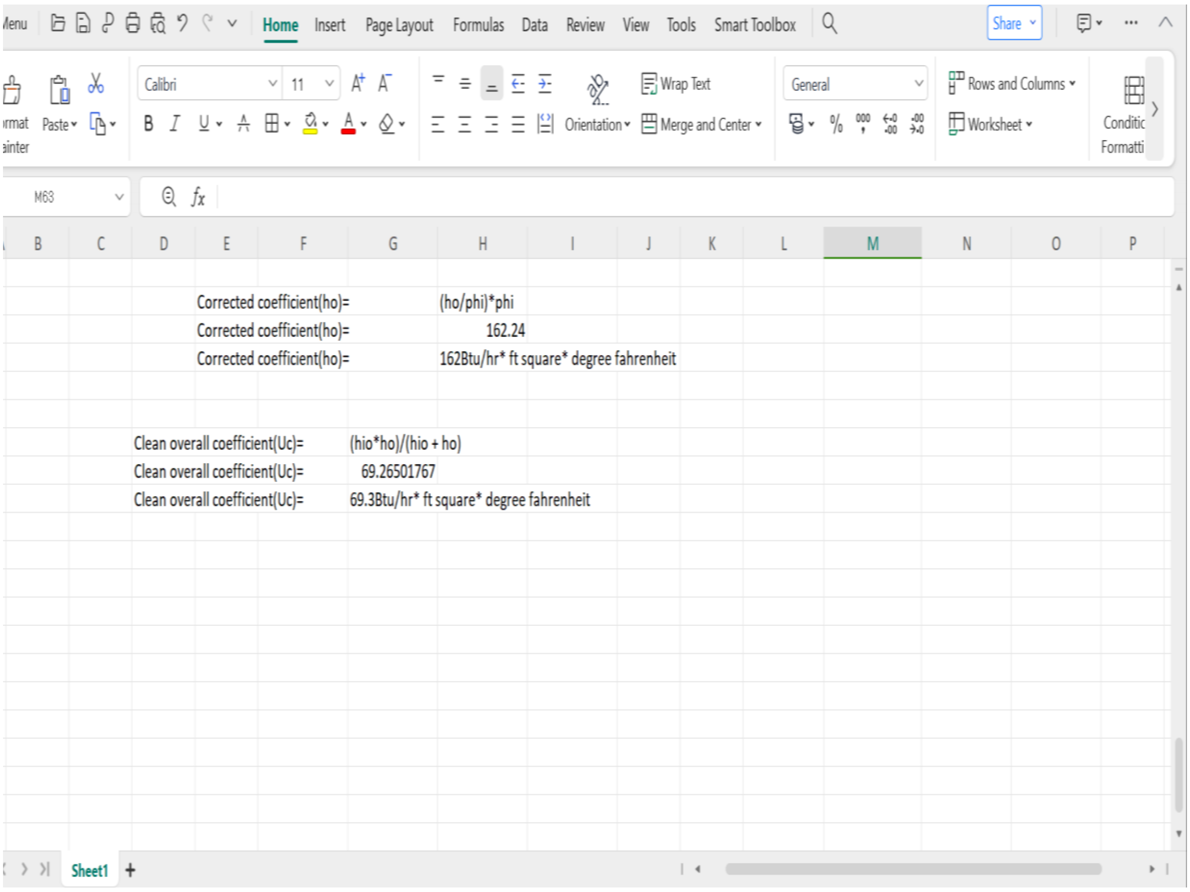
phi= (mu/(mu)w)^0.14

phi= 0.953789629

phi= 0.96

Fig 1.6: Heat Exchanger Problem (6)

Fig 1.7 Heat Exchanger Problem (7)



Corrected coefficient(ho)= (ho/phi)*phi

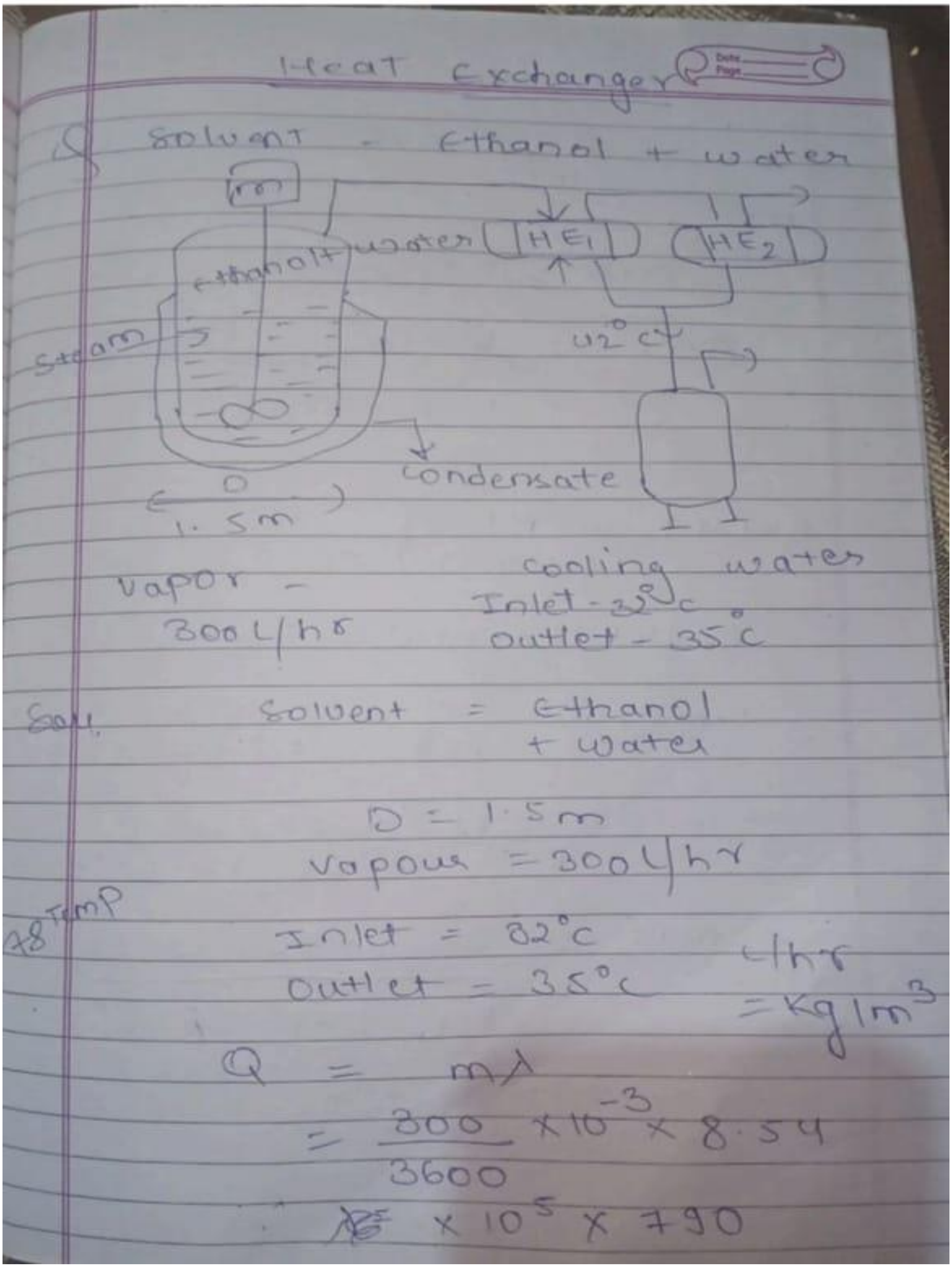
Corrected coefficient(ho)= 162.24

Corrected coefficient(ho)= 162Btu/hr* ft square* degree fahrenheit

Clean overall coefficient(Uc)= (hio*ho)/(hio + ho)

Clean overall coefficient(Uc)= 69.26501767

Clean overall coefficient(Uc)= 69.3Btu/hr* ft square* degree fahrenheit



Heat Exchanger

Q Solvent - Ethanol + water

Vapor -
300 L/hr

cooling water
Inlet - 32°c
Outlet - 35°c

Sol. Solvent = Ethanol + water

D = 1.5m

Vapour = 300 L/hr

78 Temp

Inlet = 32°c

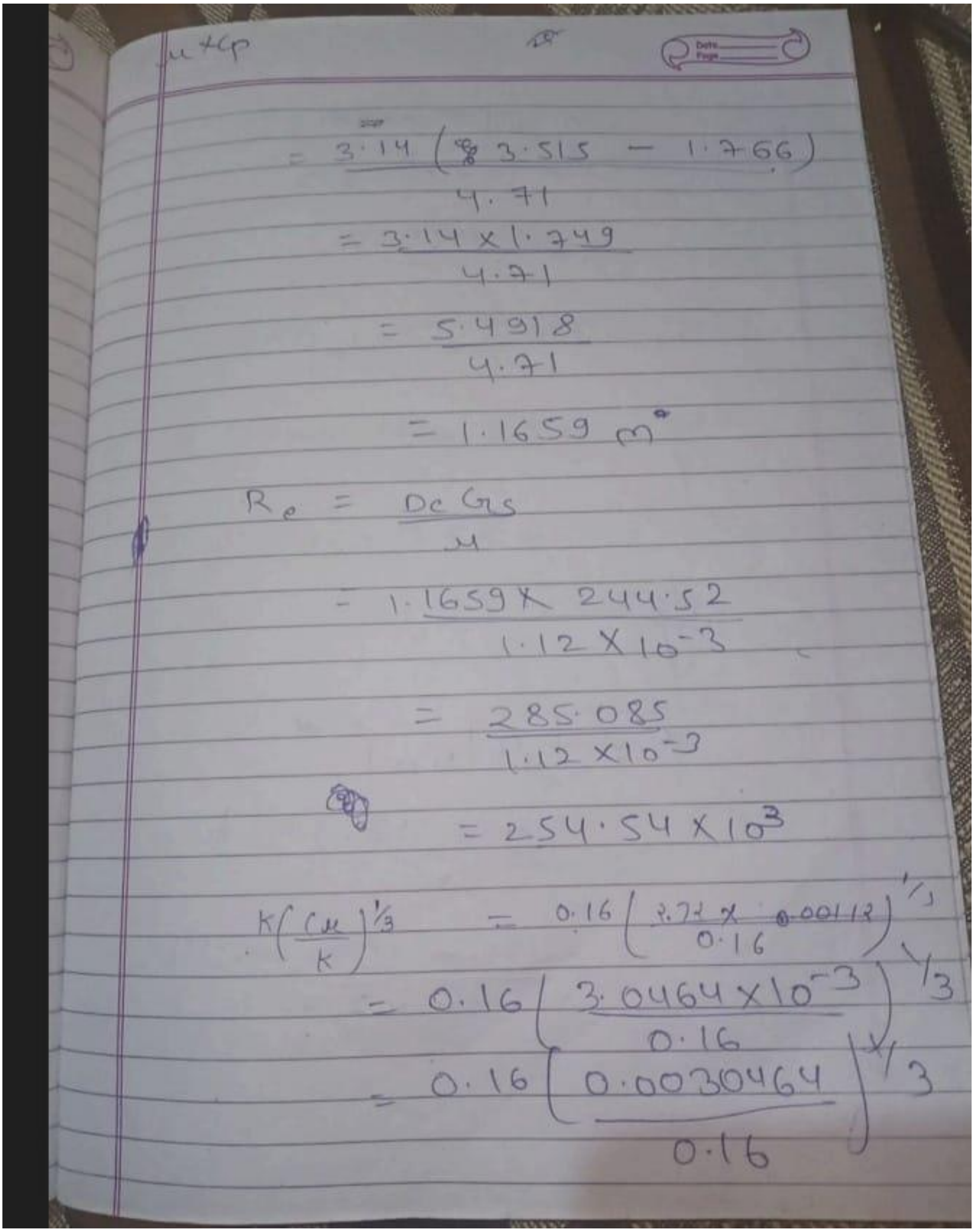
Outlet = 35°c

L/hr = kg/m^3

$$Q = m\lambda$$

$$= \frac{300}{3600} \times 10^{-3} \times 8.54$$

$$\times 10^{5} \times 790$$



μ+Cp

Date
Page

$$= \frac{3.14\ (3.515 - 1.766)}{4.71}$$

$$= \frac{3.14 \times 1.749}{4.71}$$

$$= \frac{5.4918}{4.71}$$

$$= 1.1659\ m$$

$$R_e = \frac{D_c G_s}{\mu}$$

$$= \frac{1.1659 \times 244.52}{1.12 \times 10^{-3}}$$

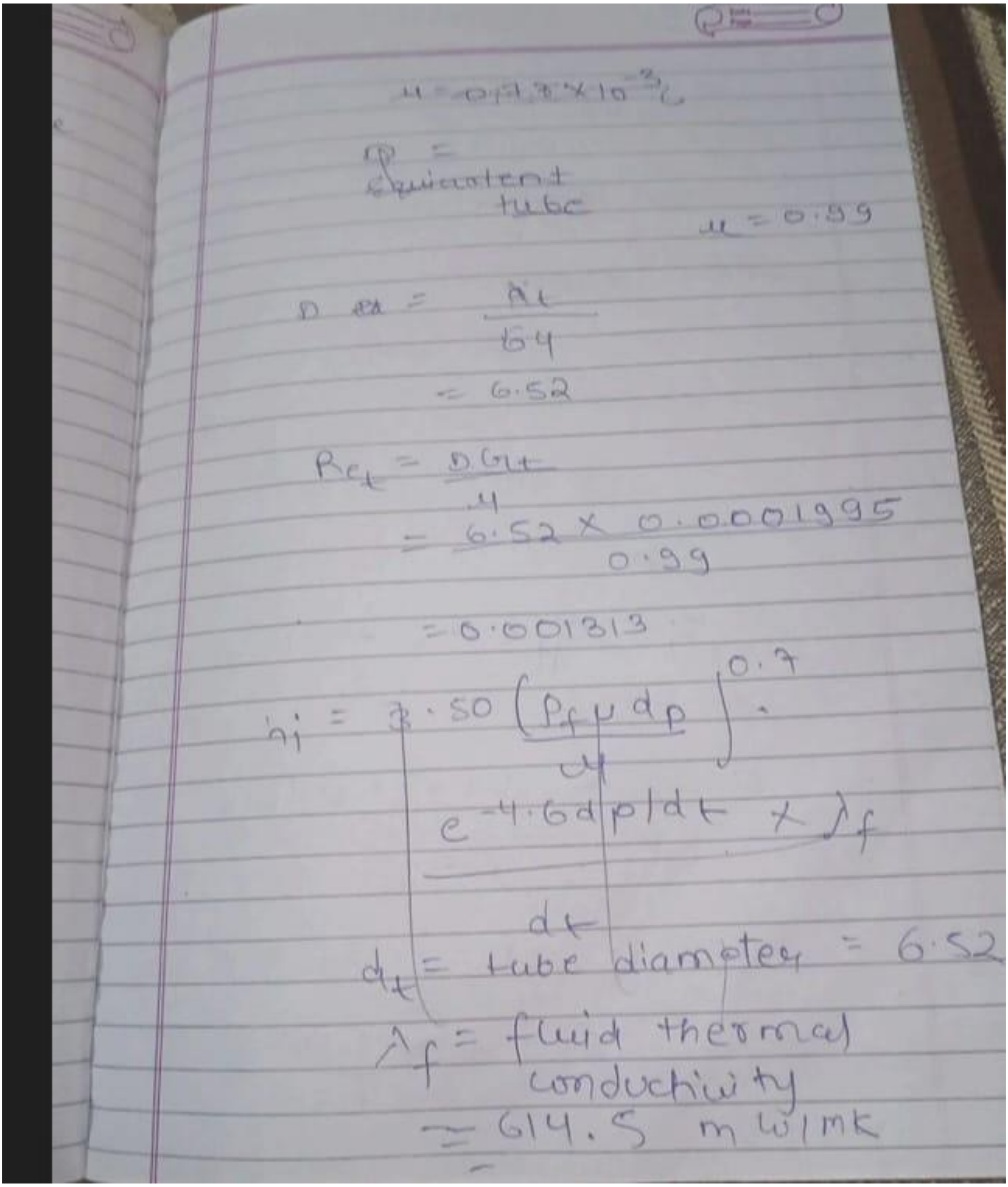
$$= \frac{285.085}{1.12 \times 10^{-3}}$$

$$= 254.54 \times 10^{3}$$

$$K\left(\frac{C\mu}{K}\right)^{1/3} = 0.16\left(\frac{2.72 \times 0.00112}{0.16}\right)^{1/3}$$

$$= 0.16\left(\frac{3.0464 \times 10^{-3}}{0.16}\right)^{1/3}$$

$$= 0.16\left(\frac{0.0030464}{0.16}\right)^{1/3}$$



$\mu = 0.778 \times 10^{-3}$ c

D =
Equivalent
tube

$\mu = 0.99$

$D_{ea} = \frac{A_t}{64}$

$= 6.52$

$Re_t = \frac{D G_t}{\mu}$

$= \frac{6.52 \times 0.0.001995}{0.99}$

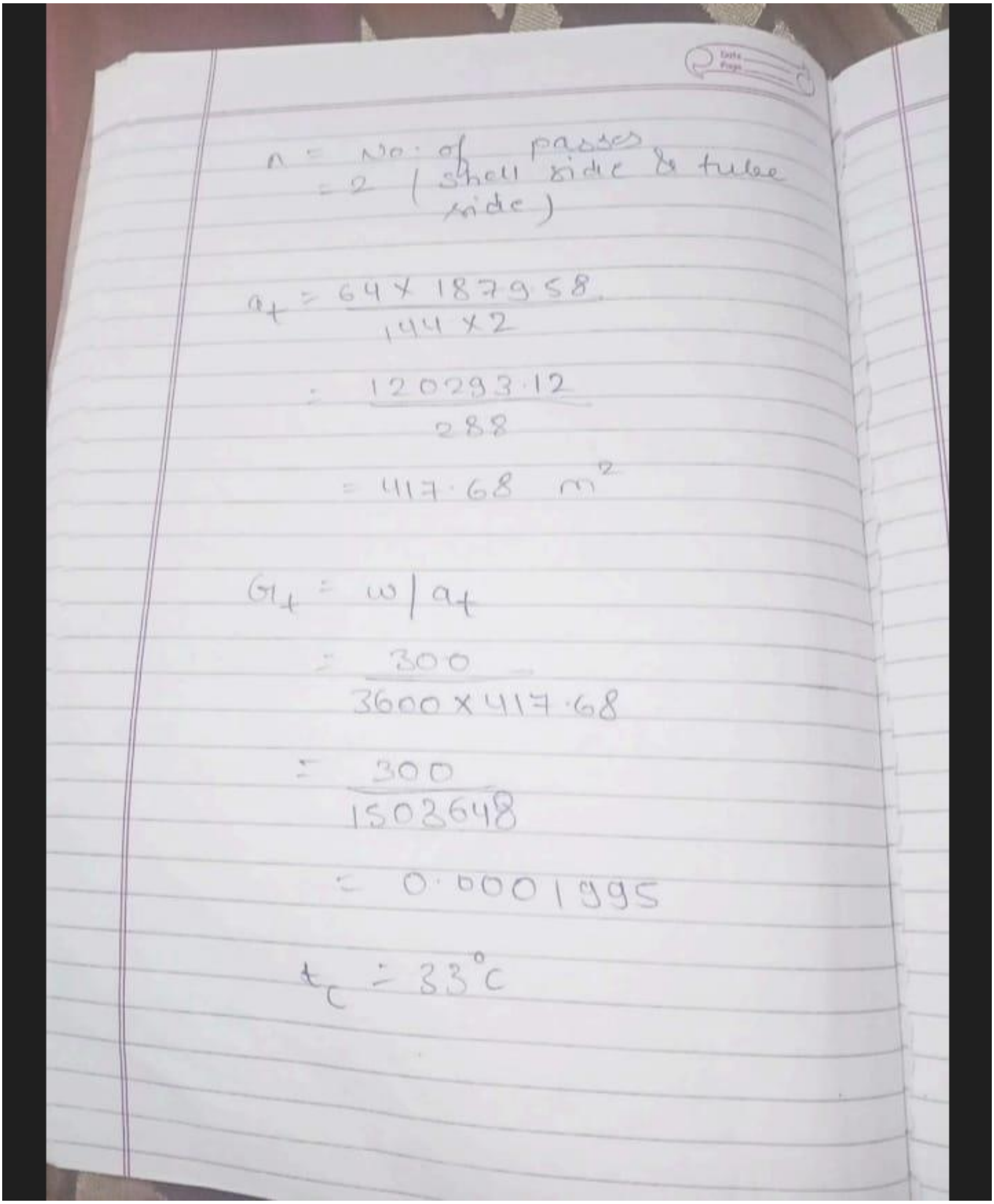
$= 0.001313$

$h_i = 3.50 \left(\frac{\rho_f u d_p}{\mu} \right)^{0.7} \cdot \frac{e^{-4.6 d_p/d_t} \times \lambda_f}{d_t}$

d_t = tube diameter = 6.52

λ_f = fluid thermal conductivity

= 614.5 mW/mK



n = No: of passes

= 2 (shell side & tube side)

$$a_t = \frac{64 \times 187958}{144 \times 2}$$

$$= \frac{120293.12}{288}$$

$$= 417.68 \ m^2$$

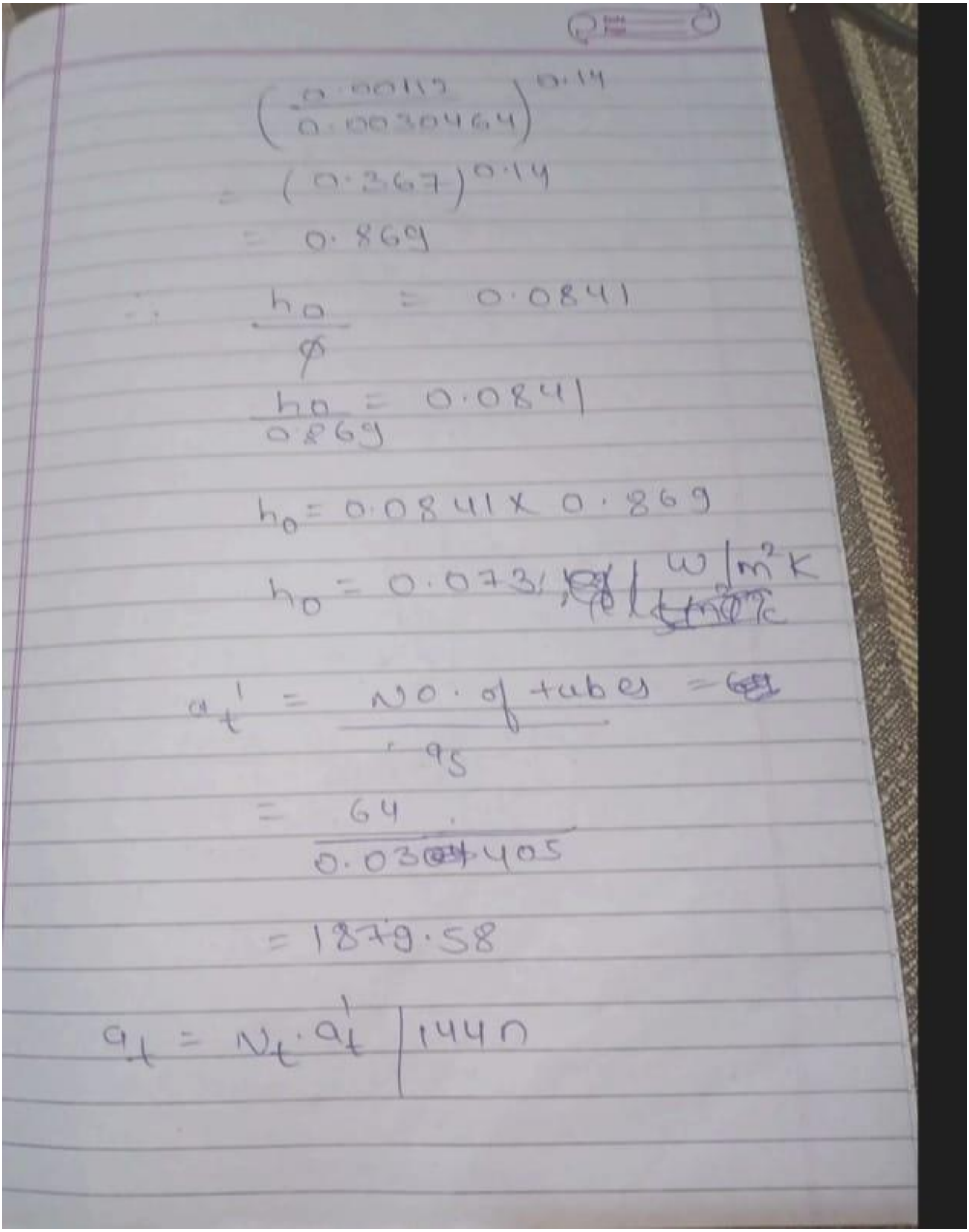
$$G_t = w / a_t$$

$$= \frac{300}{3600 \times 417.68}$$

$$= \frac{300}{1503648}$$

$$= 0.0001995$$

$$t_c = 33^\circ C$$



$$\left(\frac{0.00117}{0.0030464}\right)^{0.14}$$

$$= (0.367)^{0.14}$$

$$= 0.869$$

$$\therefore \frac{h_o}{\phi} = 0.0841$$

$$\frac{h_o}{0.869} = 0.0841$$

$$h_o = 0.0841 \times 0.869$$

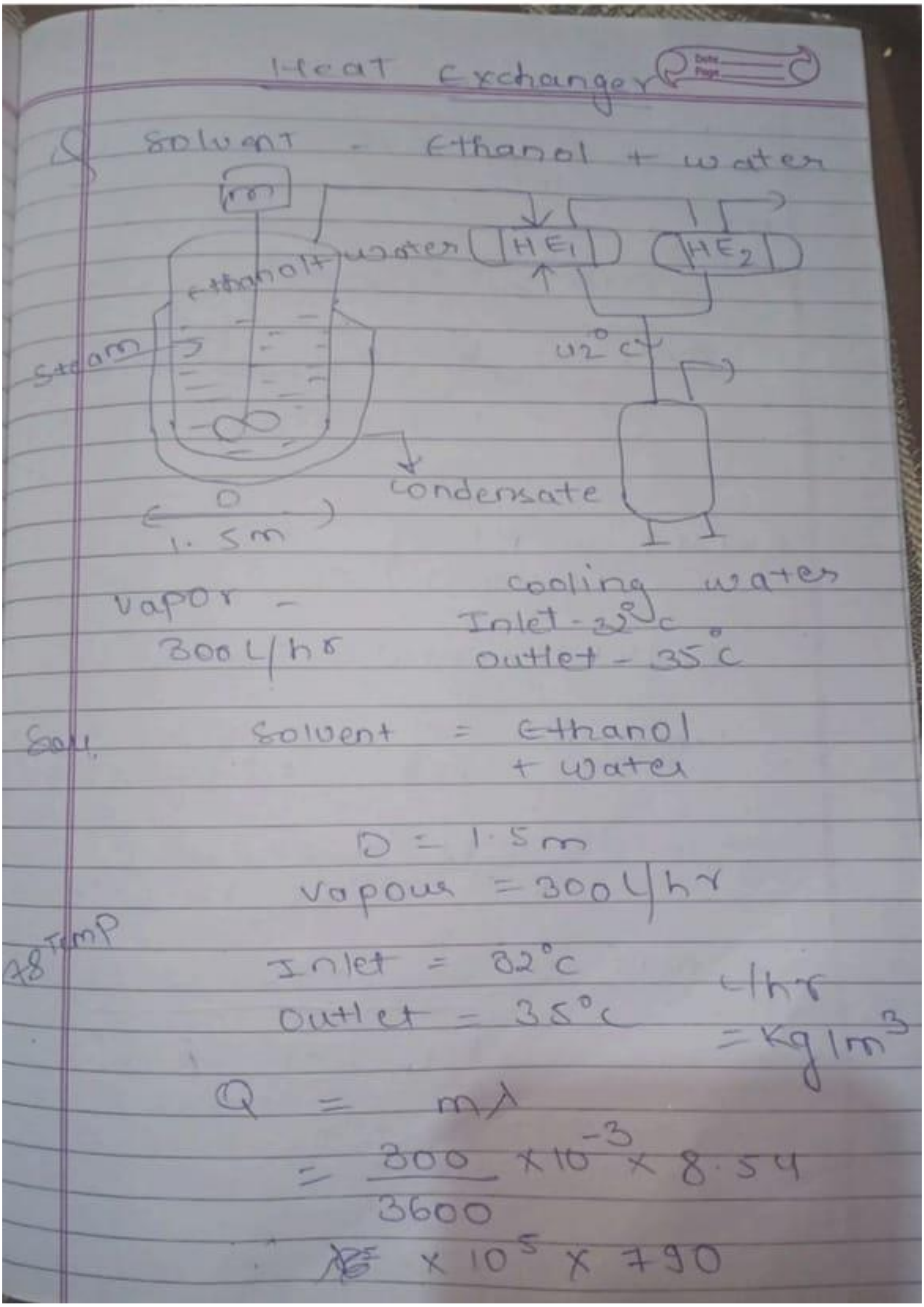
$$h_o = 0.073 \; W/m^2K$$

$$a_t' = \frac{\text{No. of tubes}}{a_s} = 64$$

$$= \frac{64}{0.03405}$$

$$= 1879.58$$

$$a_t = N_t \cdot a_t' \,/\, 144n$$



Heat Exchanger

Q Solvent - Ethanol + water

Vapor - 300 L/hr

cooling water
Inlet - 32°c
Outlet - 35°c

Sol. Solvent = Ethanol + water

D = 1.5m

Vapour = 300 L/hr

78 Temp

Inlet = 32°c

Outlet = 35°c

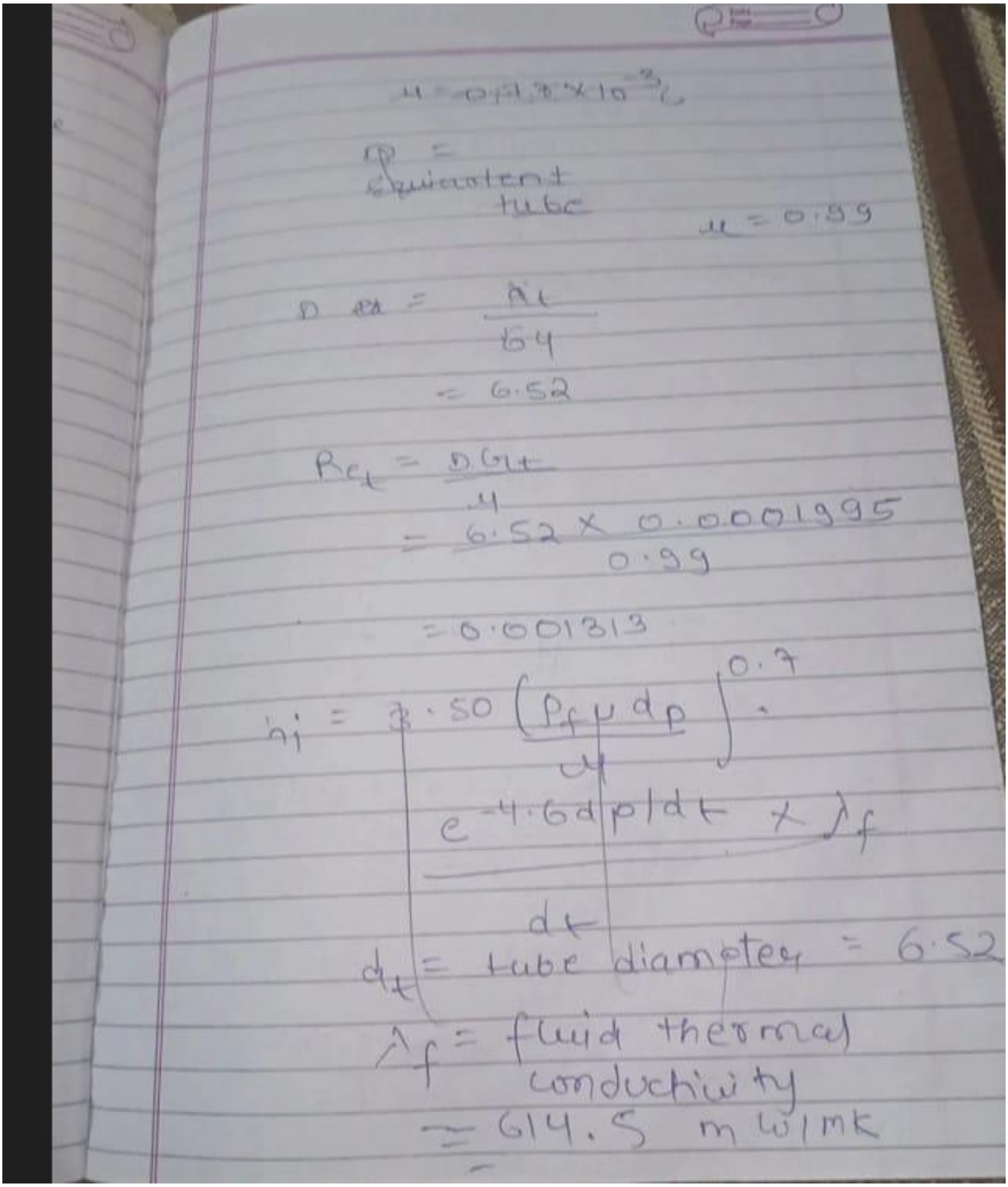
L/hr

= kg/m³

$$Q = m\lambda$$

$$= \frac{300}{3600} \times 10^{-3} \times 8.54$$

$$\cancel{85} \times 10^{5} \times 790$$



$\mu = 0.778 \times 10^{-3}$

D =
Equivalent
tube

$\mu = 0.99$

$$D_{eq} = \frac{a_t}{6.4}$$

$= 6.52$

$$Re_t = \frac{D G_t}{\mu}$$

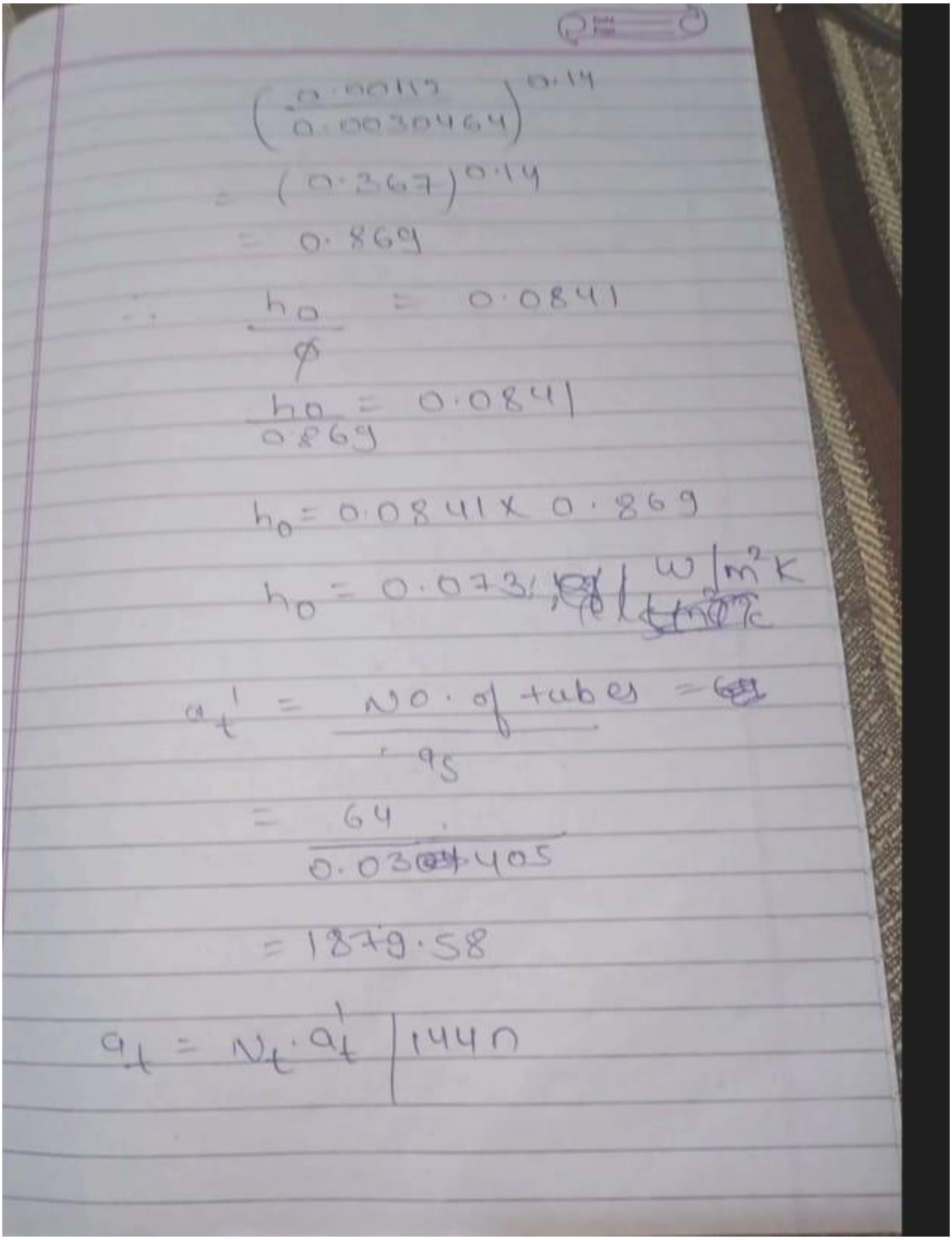
$$= \frac{6.52 \times 0.0001995}{0.99}$$

$= 0.001313$

$$h_i = 3.50 \left(\frac{\rho_f u d_p}{\mu} \right)^{0.7} \frac{e^{-4.6 d_p / d_t} \times \lambda_f}{d_t}$$

d_t = tube diameter = 6.52

λ_f = fluid thermal conductivity
= 614.5 m W/mK



$$\left(\frac{0.00112}{0.0030464}\right)^{0.14}$$

$$= (0.367)^{0.14}$$

$$= 0.869$$

$$\therefore \frac{h_o}{\phi} = 0.0841$$

$$\frac{h_o}{0.869} = 0.0841$$

$$h_o = 0.0841 \times 0.869$$

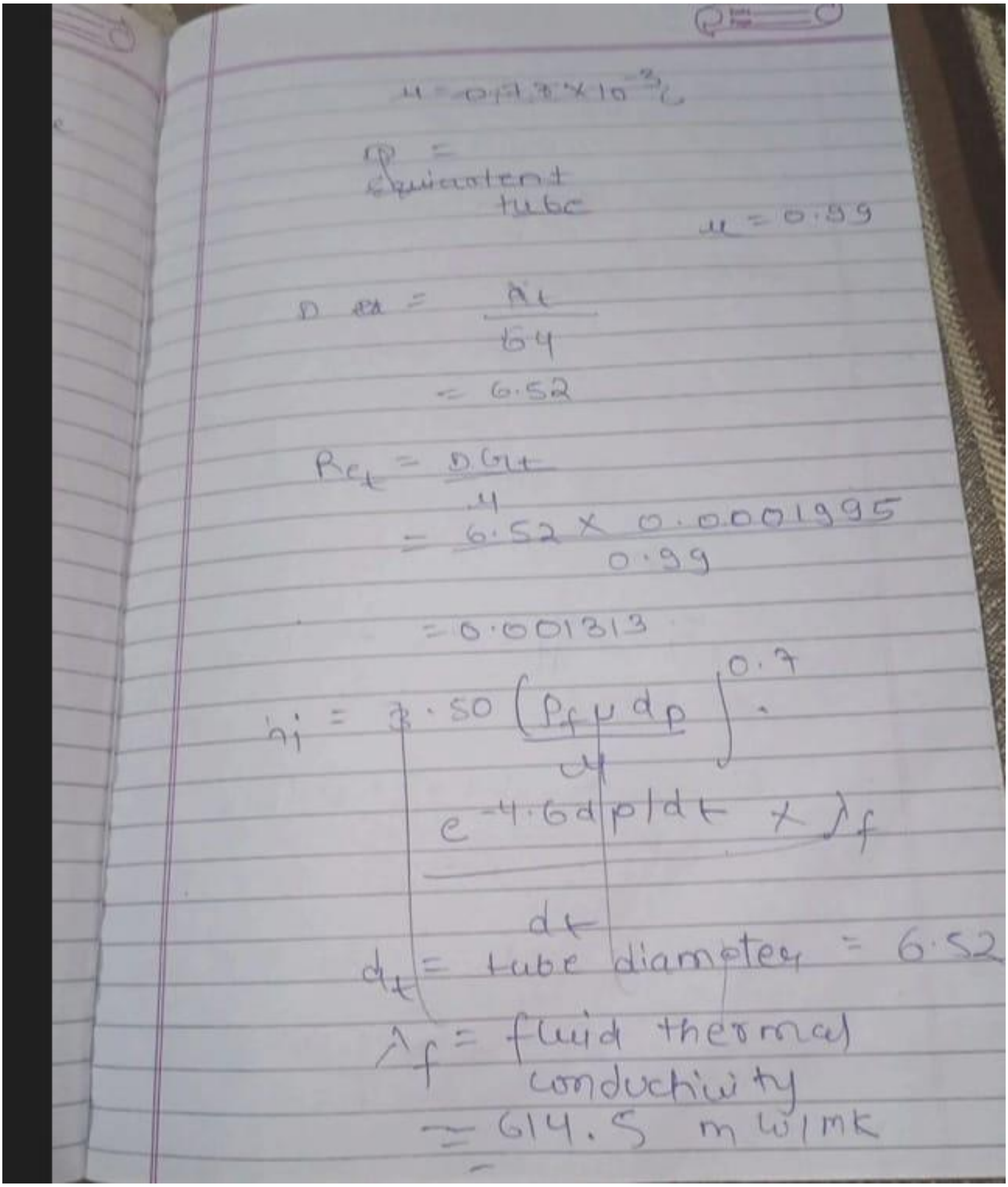
$$h_o = 0.0731 \text{ [illegible]} \; W/m^2K \; \text{[illegible]}$$

$$a_t' = \frac{\text{No. of tubes}}{a_s} = \text{[illegible]}$$

$$= \frac{64}{0.03\text{[illegible]}405}$$

$$= 1879.58$$

$$a_t = N_t \cdot a_t' \;\Big|\; 144n$$



$u = 0.478 \times 10^{-3}$ 6

D =

Equivalent tube

$u = 0.99$

$$D_{ea} = \frac{A_t}{6.4}$$

$= 6.52$

$$Re_t = \frac{D G_t}{u}$$

$$= \frac{6.52 \times 0.0001995}{0.99}$$

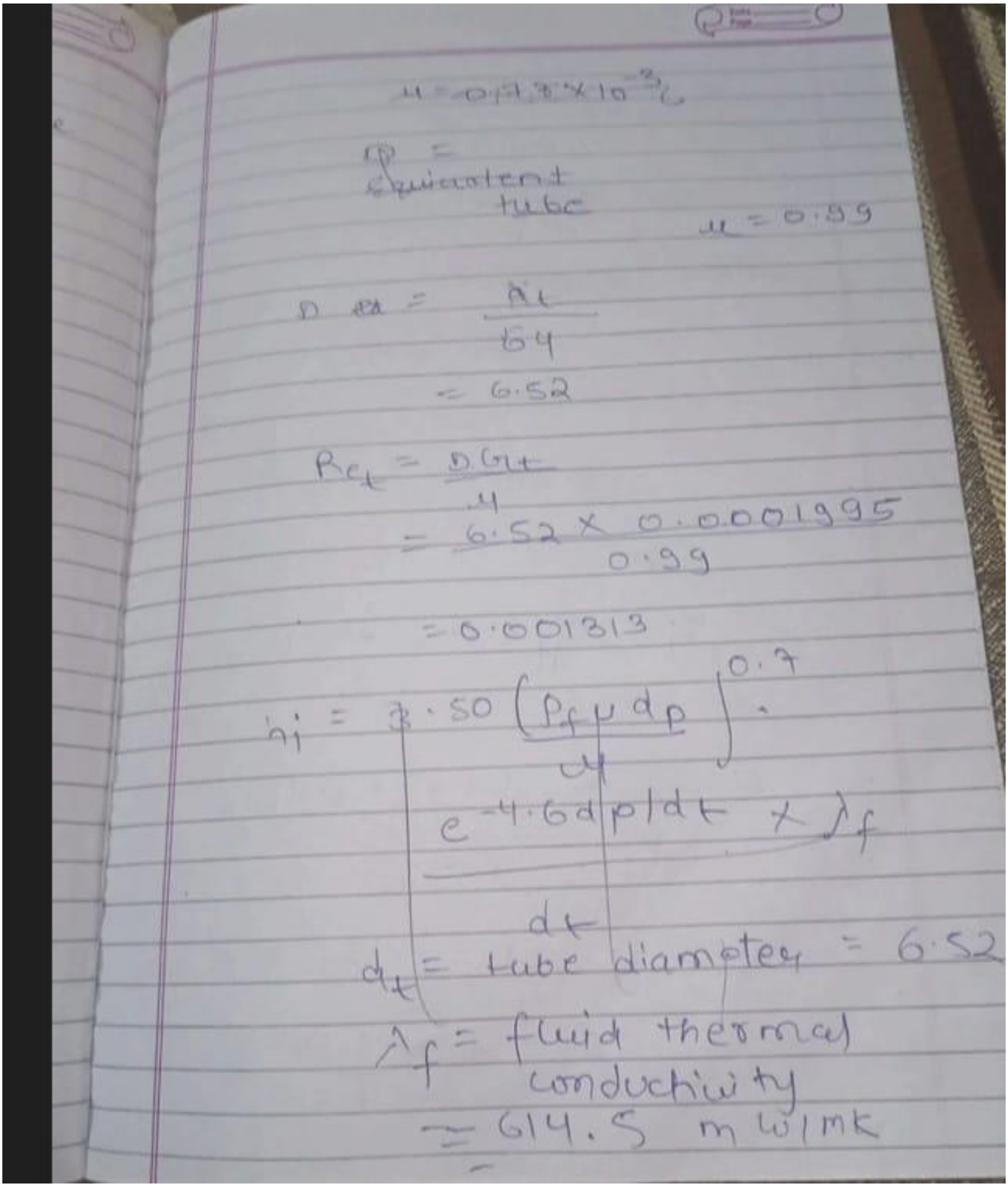
$= 0.001313$

$$h_i = 3.50 \left(\frac{\rho_f u d_p}{u} \right)^{0.7} \frac{e^{-4.6 d p / d t} \times \lambda_f}{d_t}$$

d_t = tube diameter = 6.52

λ_f = fluid thermal conductivity

= 614.5 m W/mK



~~$\mu = 0.778 \times 10^{-3}$~~

D =
Equivalent
tube

$\mu = 0.99$

$D_{eq} = \frac{A_t}{64}$

$= 6.52$

$Re_t = \frac{D G_t}{\mu}$

$= \frac{6.52 \times 0.0.0001995}{0.99}$

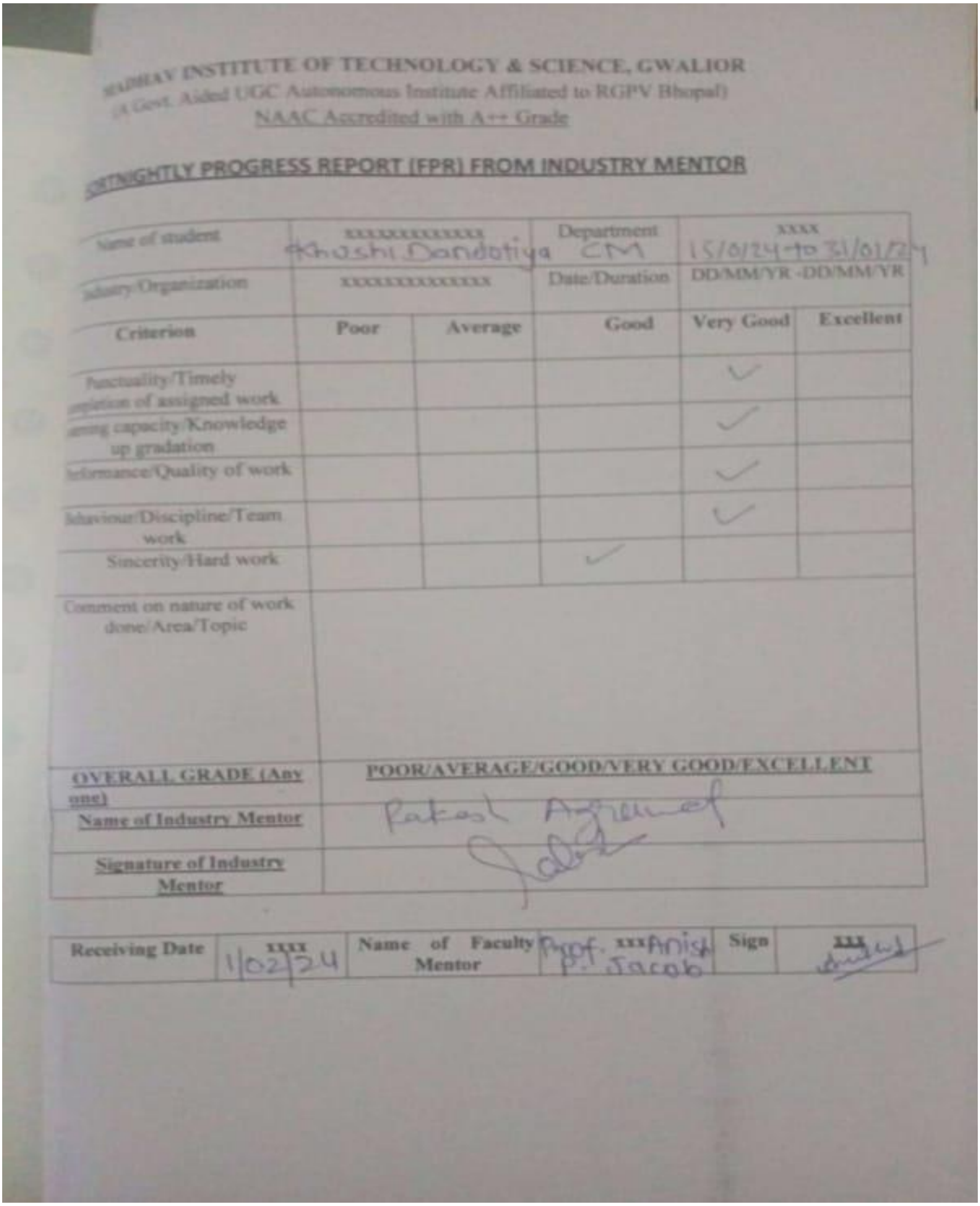
$= 0.001313$

$h_i = 3.50 \left(\frac{\rho_f \mu d_p}{\mu} \right)^{0.7} \cdot \frac{e^{-4.6 d_p/d_t} \times \lambda_f}{d_t}$

d_t = tube diameter = 6.52

λ_f = fluid thermal conductivity
= 614.5 mW/mK

FPR

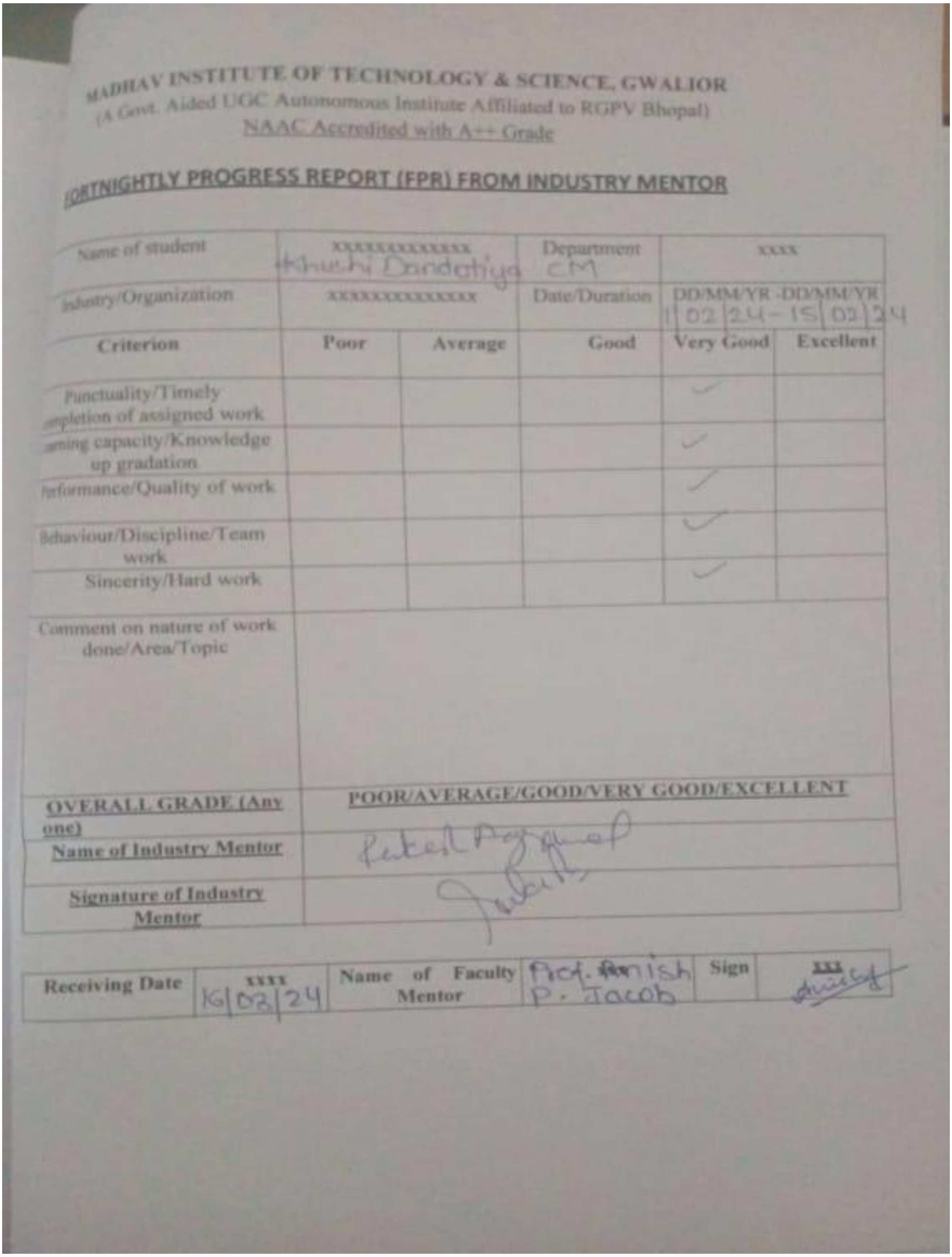


ADHAV INSTITUTE OF TECHNOLOGY & SCIENCE, GWALIOR
(A Govt. Aided UGC Autonomous Institute Affiliated to RGPV Bhopal)
NAAC Accredited with A++ Grade

RTNIGHTLY PROGRESS REPORT (FPR) FROM INDUSTRY MENTOR

Name of student	xxxxxxxxxxxxx Khushi Dandotiya		Department CM	xxxx 15/01/24 to 31/01/24	
dustry/Organization	xxxxxxxxxxxxxx		Date/Duration	DD/MM/YR -DD/MM/YR	
Criterion	**Poor**	**Average**	**Good**	**Very Good**	**Excellent**
Punctuality/Timely pletion of assigned work				✓	
arning capacity/Knowledge up gradation				✓	
erformance/Quality of work				✓	
haviour/Discipline/Team work				✓	
Sincerity/Hard work			✓		
Comment on nature of work done/Area/Topic					
OVERALL GRADE (Any one)	**POOR/AVERAGE/GOOD/VERY GOOD/EXCELLENT**				
Name of Industry Mentor	Rakesh Agrawal				
Signature of Industry Mentor					

Receiving Date	xxxx 1/02/24	**Name of Faculty Mentor**	Prof. xxx Anish P. Jacob	**Sign**	xxx

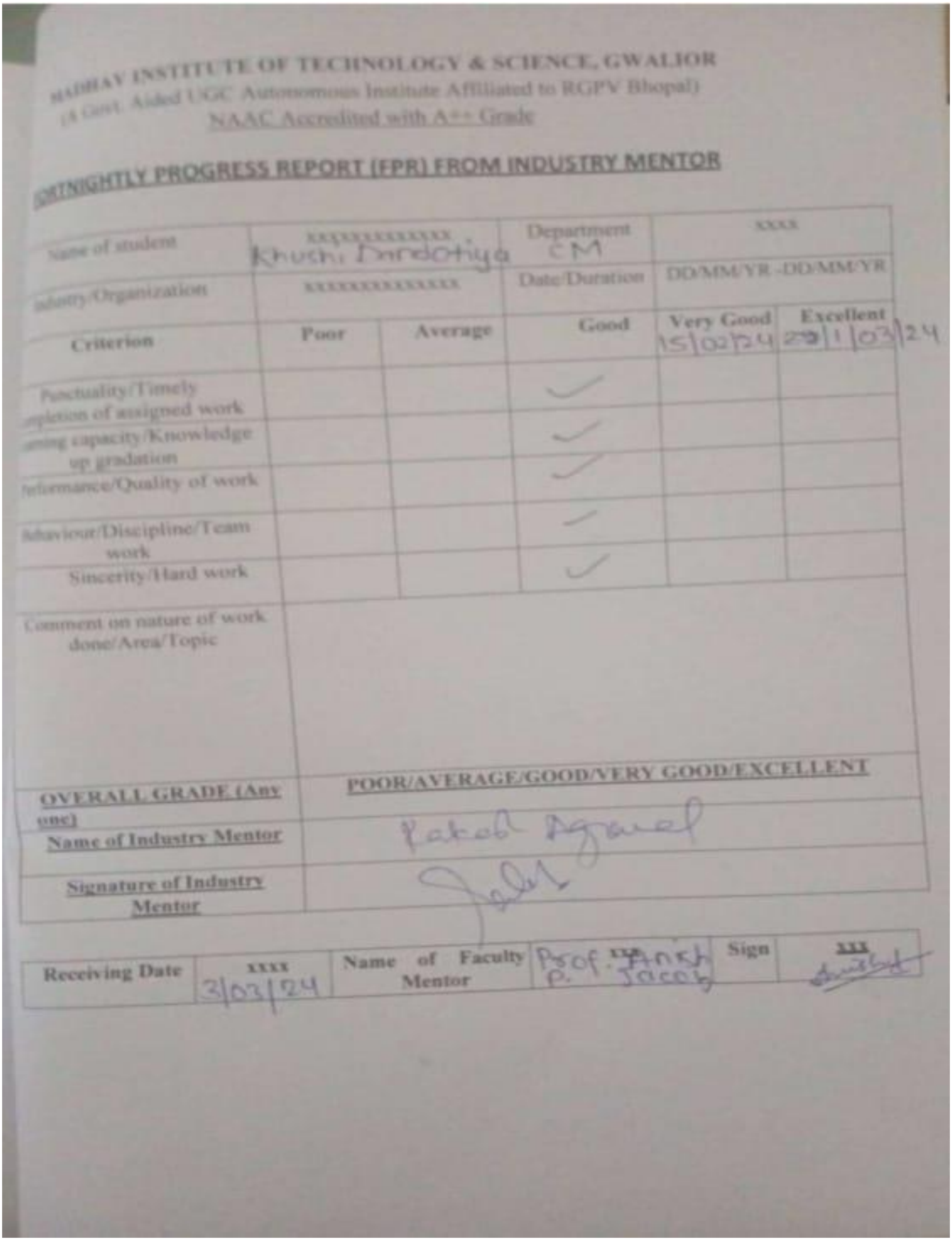


MADHAV INSTITUTE OF TECHNOLOGY & SCIENCE, GWALIOR
(A Govt. Aided UGC Autonomous Institute Affiliated to RGPV Bhopal)
NAAC Accredited with A++ Grade

FORTNIGHTLY PROGRESS REPORT (FPR) FROM INDUSTRY MENTOR

Name of student	xxxxxxxxxxxxx Khushi Dandotiya		Department CM	xxxx	
Industry/Organization	xxxxxxxxxxxxxx		Date/Duration	DD/MM/YR -DD/MM/YR 1|02|24-15|02|24	
Criterion	**Poor**	**Average**	**Good**	**Very Good**	**Excellent**
Punctuality/Timely mpletion of assigned work				✓	
rning capacity/Knowledge up gradation				✓	
erformance/Quality of work				✓	
Behaviour/Discipline/Team work				✓	
Sincerity/Hard work				✓	
Comment on nature of work done/Area/Topic					
OVERALL GRADE (Any one)	**POOR/AVERAGE/GOOD/VERY GOOD/EXCELLENT**				
Name of Industry Mentor	Puneet Agrawal				
Signature of Industry Mentor					

Receiving Date	xxxx 16|02|24	**Name of Faculty Mentor**	Prof. [illegible]nish P. Jacob	**Sign**	xxx



MADHAV INSTITUTE OF TECHNOLOGY & SCIENCE, GWALIOR
(A Govt. Aided UGC Autonomous Institute Affiliated to RGPV Bhopal)
NAAC Accredited with A++ Grade

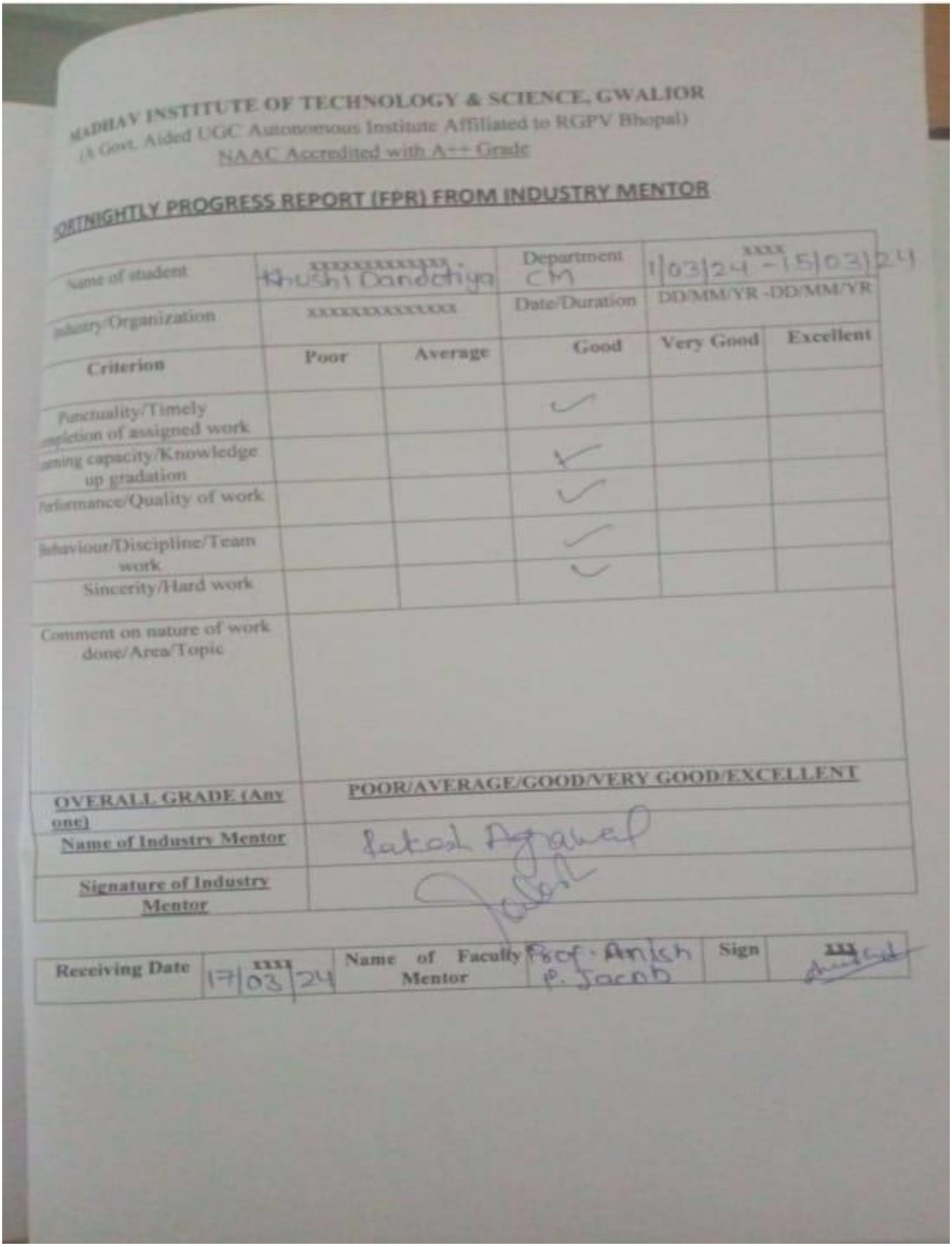
ORTNIGHTLY PROGRESS REPORT (FPR) FROM INDUSTRY MENTOR

Name of student	xxxxxxxxxxxxx Khushi Dandotiya	Department CM	xxxx
ndustry/Organization	xxxxxxxxxxxxxx	Date/Duration	DD/MM/YR -DD/MM/YR

Criterion	Poor	Average	Good	Very Good 15/02/24	Excellent 29/1/03/24
Punctuality/Timely mpletion of assigned work			✓		
arning capacity/Knowledge up gradation			✓		
erformance/Quality of work			✓		
Behaviour/Discipline/Team work			✓		
Sincerity/Hard work			✓		
Comment on nature of work done/Area/Topic					

OVERALL GRADE (Any one)	**POOR/AVERAGE/GOOD/VERY GOOD/EXCELLENT**
Name of Industry Mentor	Rakesh Agrawal
Signature of Industry Mentor	

Receiving Date	xxxx 3/03/24	**Name of Faculty Mentor**	Prof. xxx Ankit P. Jacob	**Sign**	xxx

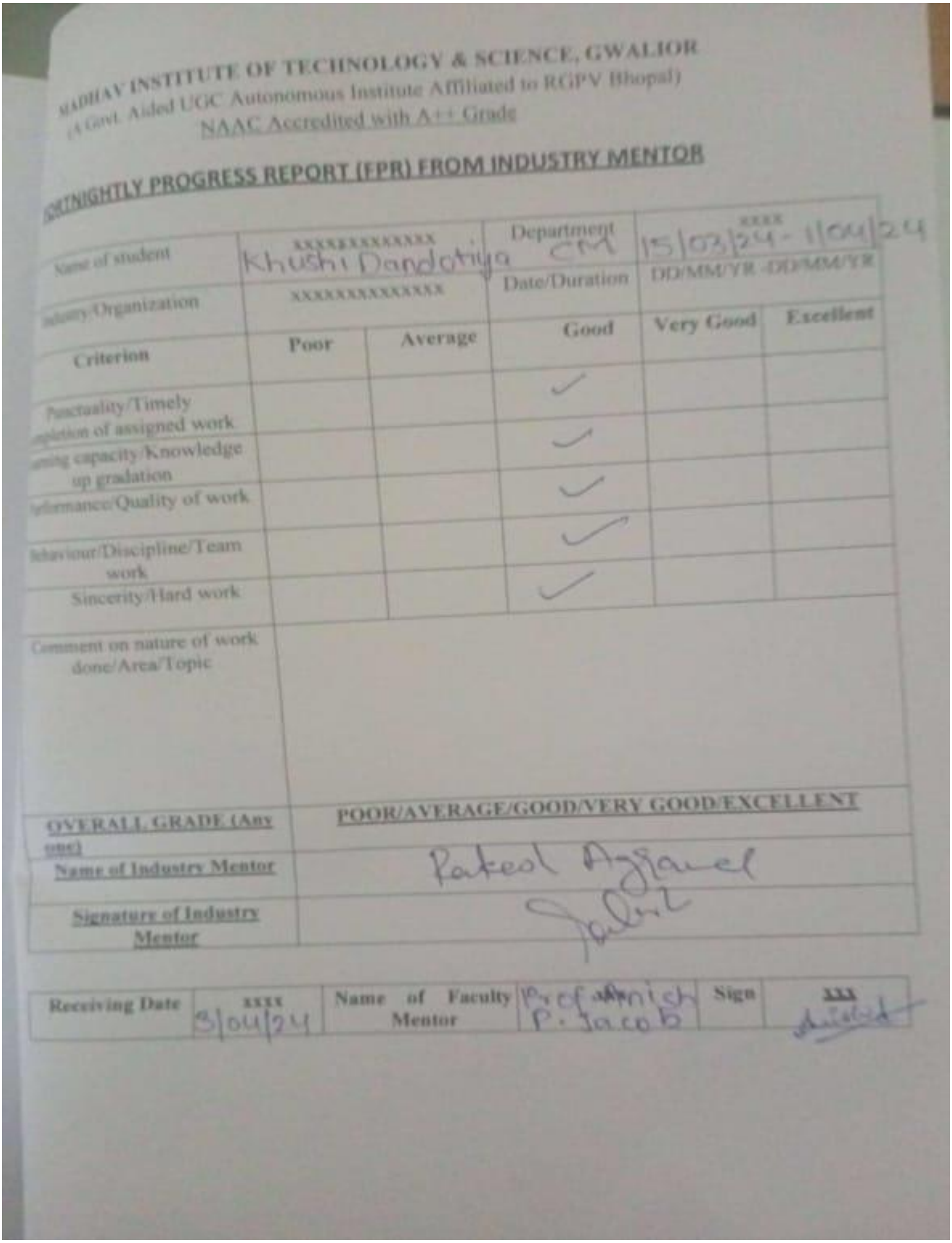


MADHAV INSTITUTE OF TECHNOLOGY & SCIENCE, GWALIOR
(A Govt. Aided UGC Autonomous Institute Affiliated to RGPV Bhopal)
NAAC Accredited with A++ Grade

ORTNIGHTLY PROGRESS REPORT (FPR) FROM INDUSTRY MENTOR

Name of student	xxxxxxxxxxxxxx. Khushi Dandotiya		Department CM	xxxx 1/03/24 - 15/03/24	
ndustry/Organization	xxxxxxxxxxxxxx		Date/Duration	DD/MM/YR -DD/MM/YR	
Criterion	**Poor**	**Average**	**Good**	**Very Good**	**Excellent**
Punctuality/Timely mpletion of assigned work			✓		
arning capacity/Knowledge up gradation			✓		
erformance/Quality of work			✓		
ehaviour/Discipline/Team work			✓		
Sincerity/Hard work			✓		
Comment on nature of work done/Area/Topic					
OVERALL GRADE (Any one)	**POOR/AVERAGE/GOOD/VERY GOOD/EXCELLENT**				
Name of Industry Mentor	Satosh Agrawal				
Signature of Industry Mentor					

Receiving Date	xxxx 17/03/24	**Name of Faculty Mentor**	Prof. Anish P. Jacob	**Sign**	xxx

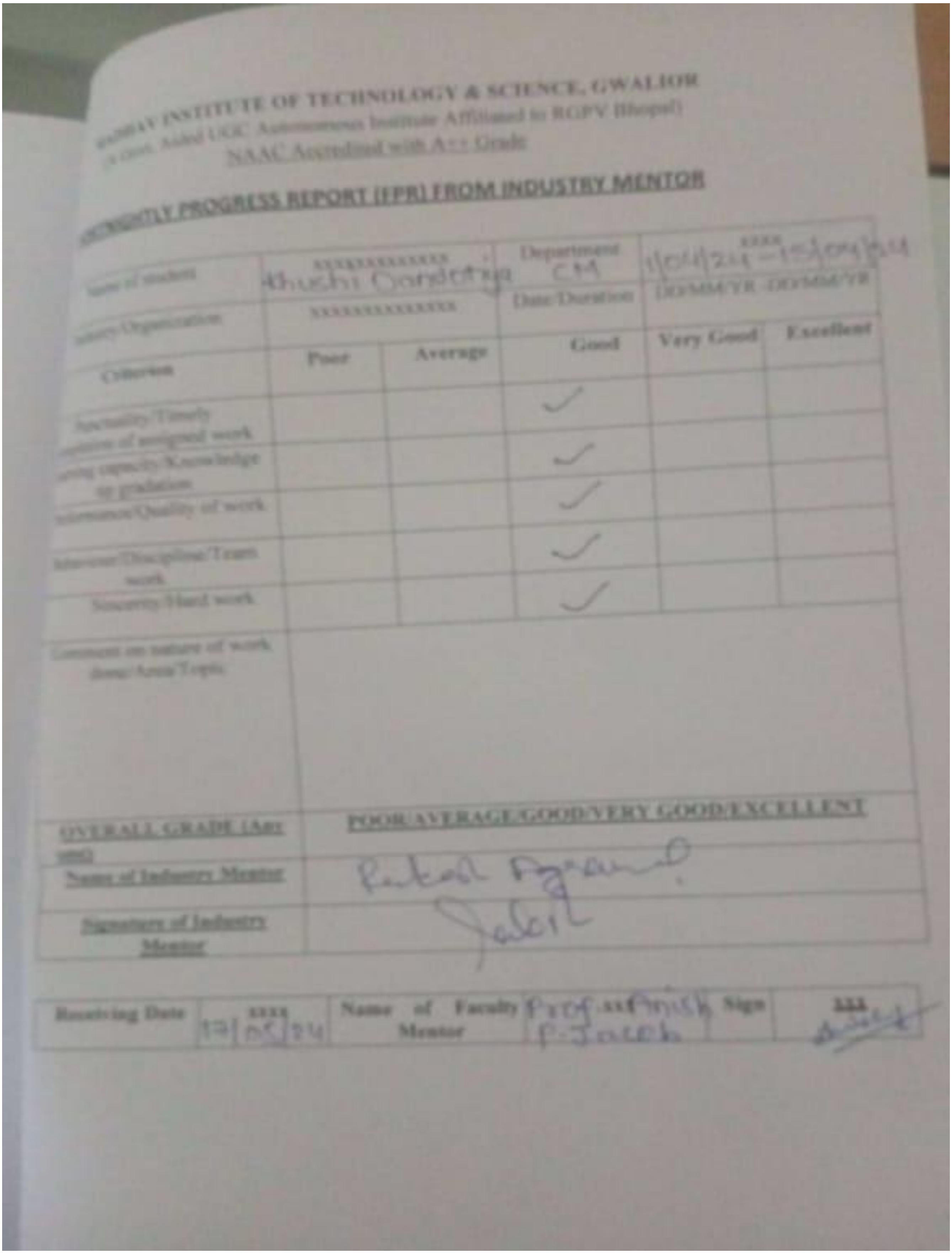


MADHAV INSTITUTE OF TECHNOLOGY & SCIENCE, GWALIOR
(A Govt. Aided UGC Autonomous Institute Affiliated to RGPV Bhopal)
NAAC Accredited with A++ Grade

ORTNIGHTLY PROGRESS REPORT (FPR) FROM INDUSTRY MENTOR

Name of student	XXXXXXXXXXXXX Khushi Dandotiya		Department CM	XXXX 15/03/24 - 1/04/24	
ndustry/Organization	XXXXXXXXXXXXXX		Date/Duration	DD/MM/YR -DD/MM/YR	
Criterion	**Poor**	**Average**	**Good**	**Very Good**	**Excellent**
Punctuality/Timely mpletion of assigned work			✓		
arning capacity/Knowledge up gradation			✓		
rformance/Quality of work			✓		
ehaviour/Discipline/Team work			✓		
Sincerity/Hard work			✓		
Comment on nature of work done/Area/Topic					
OVERALL GRADE (Any one)	**POOR/AVERAGE/GOOD/VERY GOOD/EXCELLENT**				
Name of Industry Mentor	Rakesh Aggrawal				
Signature of Industry Mentor					

Receiving Date	XXXX 3/04/24	**Name of Faculty Mentor**	Prof Manish P. Jacob	**Sign**	XXX

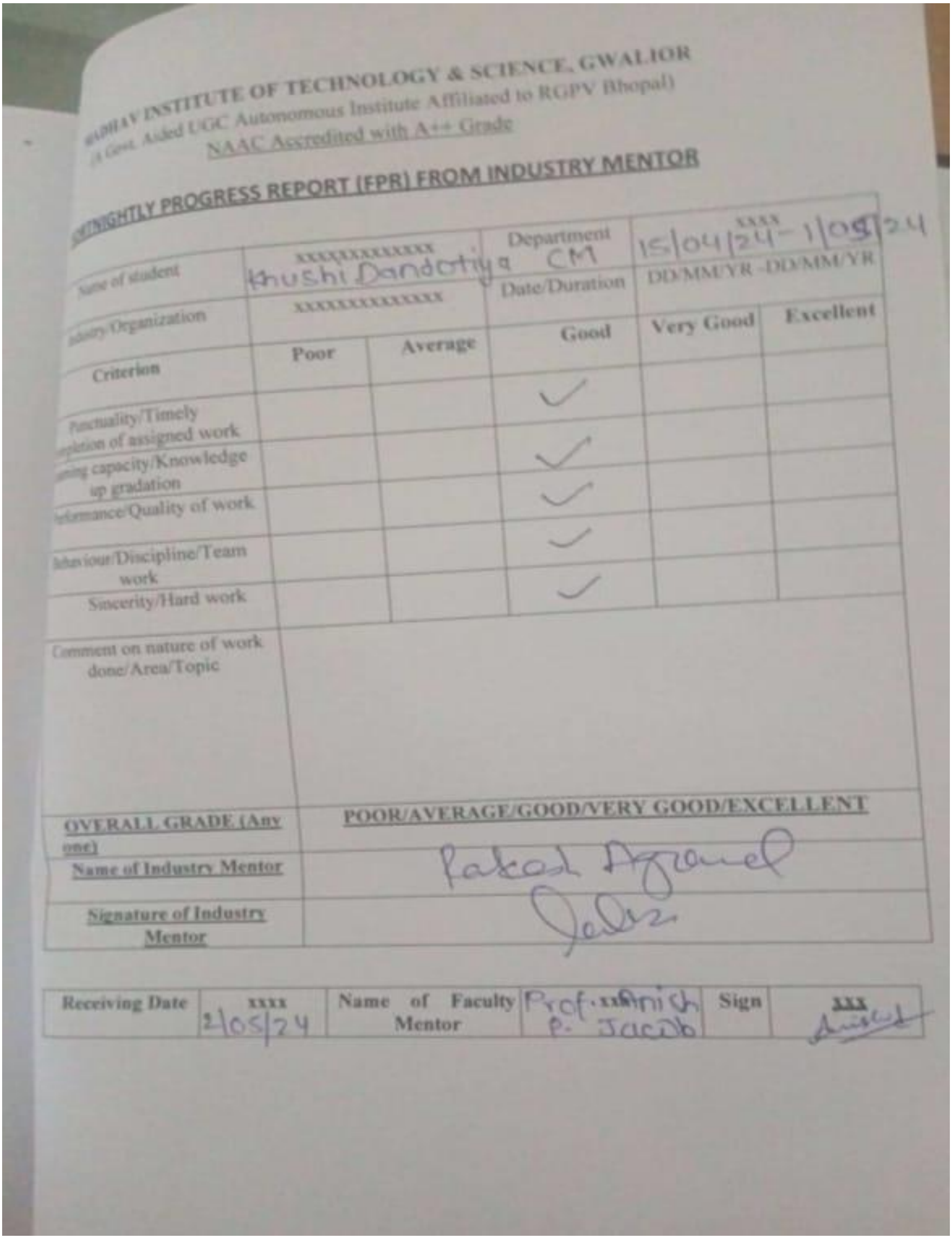


MADHAV INSTITUTE OF TECHNOLOGY & SCIENCE, GWALIOR
(A Govt. Aided UGC Autonomous Institute Affiliated to RGPV Bhopal)
NAAC Accredited with A++ Grade

FORTNIGHTLY PROGRESS REPORT (FPR) FROM INDUSTRY MENTOR

Name of student	xxxxxxxxxxxxx Khushi Gandotra		Department CM	xxxx 11/04/24 – 15/04/24 DD/MM/YR - DD/MM/YR	
Industry Organization	xxxxxxxxxxxxxxx		Date/Duration		
Criterion	Poor	Average	Good	Very Good	Excellent
Punctuality/Timely completion of assigned work			✓		
Learning capacity/Knowledge up gradation			✓		
Performance/Quality of work			✓		
Behaviour/Discipline/Team work			✓		
Sincerity/Hard work			✓		
Comment on nature of work done/Area/Topic					
OVERALL GRADE (Any one)	**POOR/AVERAGE/GOOD/VERY GOOD/EXCELLENT**				
Name of Industry Mentor	Rakesh Agrawal				
Signature of Industry Mentor					

Receiving Date	xxxx 17/05/24	**Name of Faculty Mentor**	Prof. xxx Anish P. Jacob	**Sign**	xxx

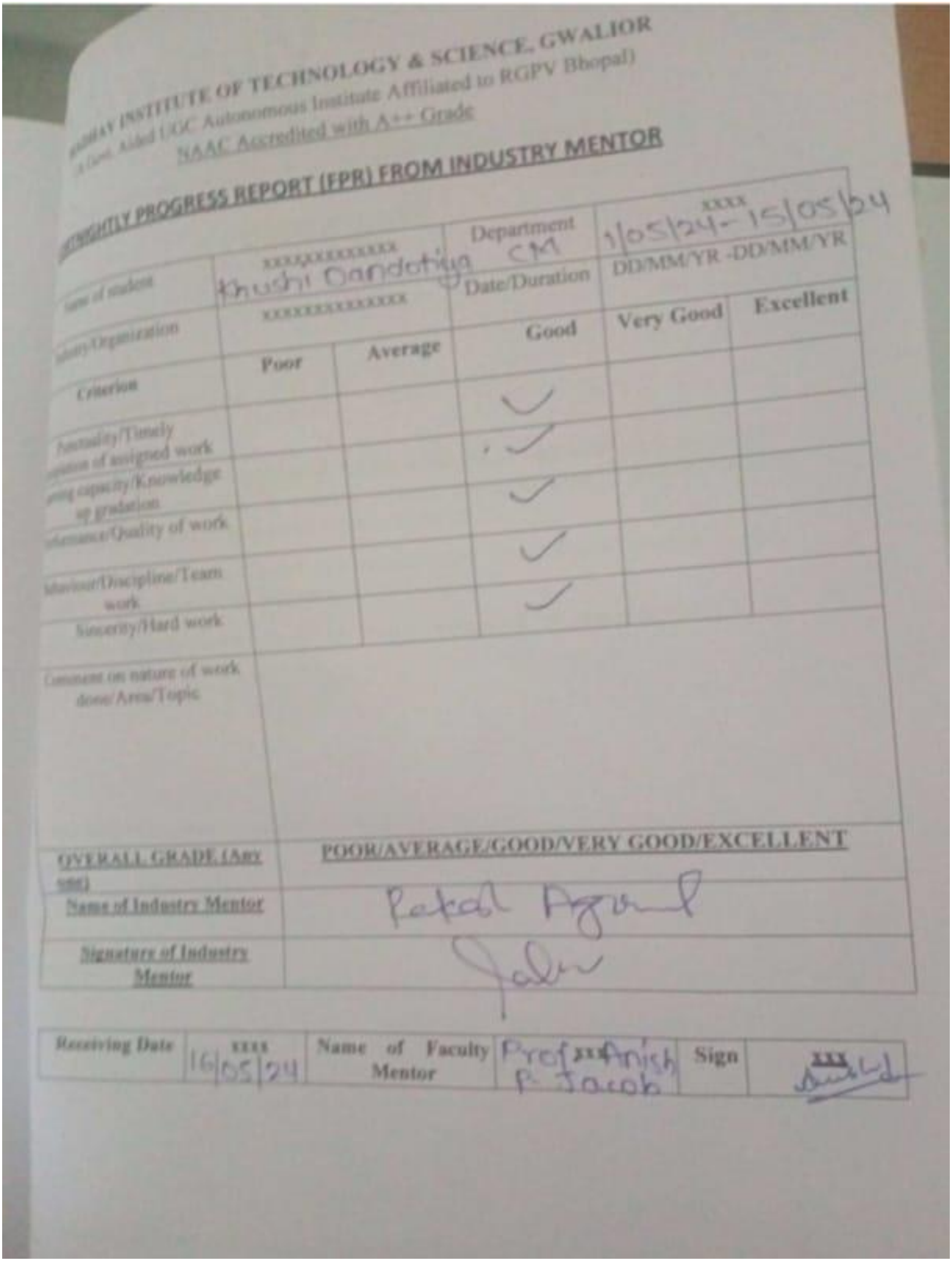


ADHAV INSTITUTE OF TECHNOLOGY & SCIENCE, GWALIOR
(A Govt. Aided UGC Autonomous Institute Affiliated to RGPV Bhopal)
NAAC Accredited with A++ Grade

RTNIGHTLY PROGRESS REPORT (FPR) FROM INDUSTRY MENTOR

ame of student	xxxxxxxxxxxxx Khushi Dandotiya		Department CM	xxxx 15/04/24 - 1/05/24	
dustry/Organization	xxxxxxxxxxxxxx		Date/Duration	DD/MM/YR -DD/MM/YR	
Criterion	Poor	Average	Good	Very Good	Excellent
Punctuality/Timely pletion of assigned work			✓		
ning capacity/Knowledge up gradation			✓		
formance/Quality of work			✓		
haviour/Discipline/Team work			✓		
Sincerity/Hard work			✓		
Comment on nature of work done/Area/Topic					
OVERALL GRADE (Any one)	**POOR/AVERAGE/GOOD/VERY GOOD/EXCELLENT**				
Name of Industry Mentor	Rakesh Agrawal				
Signature of Industry Mentor					

Receiving Date	xxxx 2/05/24	**Name of Faculty Mentor**	Prof. xxManish P. Jacob	**Sign**	xxx



AY INSTITUTE OF TECHNOLOGY & SCIENCE, GWALIOR

(A Govt. Aided UGC Autonomous Institute Affiliated to RGPV Bhopal)

NAAC Accredited with A++ Grade

TNIGHTLY PROGRESS REPORT (FPR) FROM INDUSTRY MENTOR

ame of student	xxxxxxxxxxxxxx Khushi Dandotiya		Department CM	xxxx 1/05/24-15/05/24	
ustry/Organization	xxxxxxxxxxxxxx		Date/Duration	DD/MM/YR -DD/MM/YR	
Criterion	Poor	Average	Good	Very Good	Excellent
Punctuality/Timely pletion of assigned work			✓		
ning capacity/Knowledge up gradation			✓		
formance/Quality of work			✓		
haviour/Discipline/Team work			✓		
Sincerity/Hard work			✓		
Comment on nature of work done/Area/Topic					
OVERALL GRADE (Any one)	**POOR/AVERAGE/GOOD/VERY GOOD/EXCELLENT**				
Name of Industry Mentor	Rakesh Agrawal				
Signature of Industry Mentor					

Receiving Date	xxxx 16/05/24	**Name of Faculty Mentor**	xxx Prof Anish R Jacob	**Sign**	xxx