YOUR THESIS TITLE

A THESIS

submitted in partial fulfillment of the requirements for the award of the degree

of

DOCTOR OF PHILOSOPHY

in

YOUR DEPARTMENT NAME

by

YOUR NAME

(Sch. No.: Your Scholar Number)

MAULANA AZAD
NATIONAL INSTITUTE OF TECHNOLOGY
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MONTH, YEAR

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CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in the thesis entitled **"Your Thesis Title"** in partial fulfillment of the requirement for the award of the Degree of **Doctor of Philosophy** and submitted in the **Your Department Name**, of **Maulana Azad National Institute of Technology** is an authentic record of my own work carried out during the period from **Month Year** to **Month Year** under the supervision of **Supervisor Name**, **Designation**, Department, Maulana Azad National Institute of Technology and **Co-Supervisor Name**, **Designation**, Department, Maulana Azad National Institute of Technology.

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ABSTRACT

This thesis presents research on [your research topic]. The study addresses [research problem] through [methodology].

The main contributions include:

- First contribution description
- Second contribution description
- Third contribution description

Results demonstrate that [key findings]. This work advances the field by [significance].

Keywords: Keyword 1, Keyword 2, Keyword 3

शोधप्रबंध-सार

यह शोधप्रबंध [अपने शोध विषय] पर केंद्रित है। यह अध्ययन [शोध समस्या] को [पद्धति] के माध्यम से संबोधित करता है।

मुख्य योगदान में शामिल हैं:

- पहला योगदान विवरण
- दूसरा योगदान विवरण
- तीसरा योगदान विवरण

परिणाम दर्शाते हैं कि [मुख्य निष्कर्ष]। यह कार्य [महत्व] द्वारा क्षेत्र को आगे बढ़ाता है।
मुख्य शब्द: कीवर्ड 1, कीवर्ड 2, कीवर्ड 3

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I acknowledge the financial support from [Funding Agency/Scholarship Name].

Finally, I express my heartfelt thanks to my family and friends for their unwavering support and encouragement.

Contents

List of Figures

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List of Abbreviations

AI	Artificial Intelligence
ML	Machine Learning
DL	Deep Learning
NLP	Natural Language Processing
PhD	Doctor of Philosophy
API	Application Programming Interface
GPU	Graphics Processing Unit
CPU	Central Processing Unit
RAM	Random Access Memory
URL	Uniform Resource Locator

List of Symbols

α	:	Alpha parameter
β	:	Beta coefficient
θ	:	Theta angle
σ	:	Standard deviation
μ	:	Mean
λ	:	Lambda parameter
γ	:	Gamma coefficient
ϵ	:	Epsilon (small value)
δ	:	Delta (change or difference)
ω	:	Omega (angular frequency)

Dedicated to

My Family

and

All those who supported me during this journey

Chapter 1

Introduction

This chapter demonstrates various Quarto features you can use in your thesis. Cross-references like Section 1.1, Figure 1.1, Table 1.1, and Equation 1.1 work throughout the document.

1.1 Background and Motivation

Quarto supports **bold**, *italic*, and `inline code`. You can cite references like this [1] or with multiple citations [1, 2].

1.1.1 Including Figures

You can include images from the `images/` or `Figures/` directory with captions and cross-references:

Reference figures using Figure 1.1 in your text. The figure will be automatically numbered and added to the List of Figures.

To add your own figures:

1. Place image files in the `Figures/` directory (e.g., `Figures/Chapter1/my_diagram.png`)
2. Reference them like: `![Caption here](Figures/Chapter1/my_diagram.png){#fig-my-dia width=60%}`
3. Use `@fig-my-diagram` to reference in text

FIGURE 1.1: Sample figure caption - replace with your own figure

1.2 Mathematical Equations

Inline equations use single dollar signs: $E = mc^2$ or $\alpha + \beta = \gamma$

Display equations use double dollar signs:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \epsilon \tag{1.1}$$

You can reference equations like Equation 1.1 in your text.

More complex equations with Greek letters:

$$\mathcal{L}_{CE} = -\sum_{i=1}^{N} \sum_{c=1}^{C} y_{ic} \log(\hat{y}_{ic}) \tag{1.2}$$

where $\mathcal{L}_{CE}$ is the cross-entropy loss (Equation 1.2), N is the number of samples, C is the number of classes, y_{ic} is the true label, and $\hat{y}_{ic}$ is the predicted probability.

Matrix notation example:

$$\mathbf{H} = \text{ReLU}(\mathbf{W}_1 \mathbf{X} + \mathbf{b}_1) \tag{1.3}$$

1.3 Tables

1.3.1 Simple Markdown Tables

TABLE 1.1: Comparison of different methods

Method	Accuracy	F1-Score	Reference
Method A	85.2%	0.847	[1]
Method B	87.5%	0.871	[2]
Method C	89.1%	0.885	[3]

Reference tables using Table 1.1 in your text. Tables are automatically numbered and added to the List of Tables.

1.3.2 Tables with Custom Column Widths

TABLE 1.2: Advantages and disadvantages

Approach	Strengths	Weaknesses	Scalability
Rule-based	Simple to implement	Limited flexibility	Low
Machine Learning	Data-driven	Requires large datasets	Medium
Deep Learning	High accuracy	Computationally expensive	High

1.4 Lists and Structure

1.4.1 Bullet Lists

- First item with **bold text**

- Second item with *italic text*
- Third item with `inline code`
  - Nested item A
  - Nested item B

1.4.2 Numbered Lists

1. Data collection and preprocessing
2. Model architecture design
3. Training and validation
4. Performance evaluation
5. Result analysis

1.4.3 Definition Lists

Accuracy The proportion of correct predictions among total predictions

Precision The proportion of true positives among all positive predictions

Recall The proportion of true positives among all actual positives

1.5 Research Questions

This research aims to answer the following questions:

1. **RQ1**: What is the first research question?
2. **RQ2**: What is the second research question?
3. **RQ3**: What is the third research question?

1.6 Contributions

The main contributions of this thesis are:

- **Contribution 1**: Description of first contribution
- **Contribution 2**: Description of second contribution
- **Contribution 3**: Description of third contribution

1.7 Thesis Structure

This thesis is organized as follows:

- **Chapter 2** presents the literature review and related work
- **Chapter 3** describes the research methodology
- **Chapter 4** presents experimental results
- **Chapter 5** discusses findings and implications
- **Chapter 6** concludes and outlines future work

Chapter 2

Literature Review

This chapter reviews the existing literature relevant to your research topic.

2.1 Overview

Provide a brief overview of what will be covered in this literature review chapter.

2.2 Theoretical Background

Discuss the theoretical foundations and key concepts related to your research.

2.2.1 Key Concept 1

Explain the first key concept or theory relevant to your work.

2.2.2 Key Concept 2

Explain the second key concept or theory.

2.3 Related Work

Review previous research that is related to your study.

2.3.1 Approach A

Discuss one category of approaches or methodologies used in previous research.

2.3.2 Approach B

Discuss another category of approaches.

2.4 Research Gaps

Identify the gaps in existing literature that your research aims to address:

1. **Gap 1**: Existing methods do not adequately address…
2. **Gap 2**: Previous research has not explored…
3. **Gap 3**: There is limited work on…

2.5 Summary

Summarize the key findings from the literature review and how they relate to your research objectives.

Chapter 3

Methodology

This chapter presents the research methodology and demonstrates how to include algorithms and mathematical formulations.

3.1 Research Framework

Describe your overall research approach here. You can reference sections like Section 3.3 or equations like Equation 3.1.

3.2 Data Collection and Preprocessing

3.2.1 Dataset Description

Describe your datasets. Example table:

TABLE 3.1: Dataset split information

Dataset	Size	Classes	Purpose
Training Set	8,000	5	Model training
Validation Set	1,000	5	Hyperparameter tuning
Test Set	1,000	5	Final evaluation

3.2.2 Preprocessing Steps

The preprocessing pipeline consists of:

1. **Tokenization**: Split text into tokens
2. **Normalization**: Convert to lowercase, remove punctuation
3. **Filtering**: Remove stop words and rare tokens
4. **Encoding**: Convert tokens to numerical representations

3.2.3 Preprocessing Algorithm

Algorithm 3.1 Text Preprocessing Pipeline

Input: Raw text corpus $D = \{d_1, d_2, \dots, d_n\}$

Input: Stop words list S, minimum frequency threshold τ

Output: Preprocessed corpus $D' = \{d'_1, d'_2, \dots, d'_n\}$

$D' \leftarrow \emptyset$
Build vocabulary V from all tokens in D
Filter V to remove tokens with frequency $< \tau$
for all document d_i in D **do**
    $tokens \leftarrow \text{Tokenize}(d_i)$
    $tokens \leftarrow \text{LowerCase}(tokens)$
    $tokens \leftarrow \text{RemoveStopWords}(tokens, S)$
    $tokens \leftarrow \text{Lemmatize}(tokens)$
    $tokens \leftarrow \text{FilterVocabulary}(tokens, V)$
    $d'_i \leftarrow \text{Join}(tokens)$
    $D' \leftarrow D' \cup \{d'_i\}$
end for
return D'

The preprocessing algorithm (Algorithm 3.1) is applied before model training.

3.3 Model Architecture

3.3.1 Neural Network Design

The encoder transforms input sequences into hidden representations:

$$\mathbf{h}_t = \text{LSTM}(\mathbf{x}_t, \mathbf{h}_{t-1}) \tag{3.1}$$

where $\mathbf{x}_t$ is the input at time t and $\mathbf{h}_{t-1}$ is the previous hidden state.

3.3.2 Attention Mechanism

The attention weights are computed as:

$$\alpha_{t,i} = \frac{\exp(e_{t,i})}{\sum_{j=1}^{T} \exp(e_{t,j})} \tag{3.2}$$

The context vector combines hidden states:

$$\mathbf{c}_t = \sum_{i=1}^{T} \alpha_{t,i} \mathbf{h}_i \tag{3.3}$$

3.3.3 Algorithm Example

Here's how to include algorithms using pseudocode blocks:

Algorithm 3.2 Training Algorithm with Early Stopping

Input: Training data $\mathcal{D}_{train}$, validation data $\mathcal{D}_{val}$

Input: Learning rate η, batch size B, patience P

Output: Trained model parameters θ^*

Initialize parameters θ randomly
$best\_loss \leftarrow \infty$
$patience\_counter \leftarrow 0$
while $patience\_counter < P$ **do**
    for all mini-batch $\mathcal{B}$ in $\mathcal{D}_{train}$ **do**
        Compute predictions $\hat{y} = f(x; \theta)$
        Compute loss $\mathcal{L}(\hat{y}, y)$
        Update $\theta \leftarrow \theta - \eta \nabla_\theta \mathcal{L}$
    end for
    $val\_loss \leftarrow$ Evaluate$(\mathcal{D}_{val}, \theta)$
    if $val\_loss < best\_loss$ **then**
        $best\_loss \leftarrow val\_loss$
        $\theta^* \leftarrow \theta$
        $patience\_counter \leftarrow 0$
    else
        $patience\_counter \leftarrow patience\_counter + 1$
    end if
end while
return θ^*

You can reference algorithms using Algorithm 3.2 in your text.

3.4 Loss Function

We use cross-entropy loss for classification:

$$\mathcal{L}_{CE} = -\frac{1}{N}\sum_{i=1}^{N}\sum_{c=1}^{C} y_{i,c}\log(\hat{y}_{i,c}) \tag{3.4}$$

With L2 regularization:

$$\mathcal{L}_{total} = \mathcal{L}_{CE} + \lambda\|\mathbf{W}\|_2^2 \tag{3.5}$$

3.5 Evaluation Metrics

Standard classification metrics:

TABLE 3.2: Classification metrics

Metric	Formula	Interpretation
Accuracy	$\frac{TP+TN}{TP+TN+FP+FN}$	Overall correctness
Precision	$\frac{TP}{TP+FP}$	Positive prediction accuracy
Recall	$\frac{TP}{TP+FN}$	True positive detection rate
F1-Score	$\frac{2\cdot P\cdot R}{P+R}$	Harmonic mean

3.6 Implementation Details

3.6.1 Hyperparameters

TABLE 3.3: Model hyperparameters

Parameter	Value	Description
Learning rate	0.001	Adam optimizer
Batch size	32	Mini-batch size
Embedding dim	300	Word embedding dimension
Hidden units	256	LSTM hidden size

Parameter	Value	Description
Dropout	0.5	Dropout probability

3.6.2 Code Example (Optional)

You can include Python code blocks:

```
import torch
import torch.nn as nn

class SimpleModel(nn.Module):
    def __init__(self, vocab_size, embed_dim, hidden_dim):
        super(SimpleModel, self).__init__()
        self.embedding = nn.Embedding(vocab_size, embed_dim)
        self.lstm = nn.LSTM(embed_dim, hidden_dim, batch_first=True)
        self.fc = nn.Linear(hidden_dim, num_classes)

    def forward(self, x):
        embedded = self.embedding(x)
        lstm_out, _ = self.lstm(embedded)
        output = self.fc(lstm_out[:, -1, :])
        return output
```

3.7 Summary

This chapter presented:

1. Research framework and data preprocessing (Section 3.2)
2. Model architecture with attention mechanism (Section 3.3)
3. Loss functions and evaluation metrics (Section 3.5)

4. Implementation details and hyperparameters (Table 3.3)

The next chapter presents experimental results.

Chapter 4

Results and Analysis

This chapter presents experimental results and performance analysis.

4.1 Experimental Setup

4.1.1 Datasets

We evaluated our approach on multiple datasets:

TABLE 4.1: Dataset characteristics

Dataset	Domain	Samples	Classes	Source
Dataset A	Text	10,000	5	[1]
Dataset B	Reviews	25,000	3	[2]
Dataset C	Social Media	15,000	8	Public corpus

4.1.2 Baseline Methods

Comparison with existing approaches:

TABLE 4.2: Baseline methods

Method	Type	Year	Key Feature
Baseline 1	Traditional	2020	TF-IDF features
Baseline 2	Deep Learning	2021	CNN architecture

Method	Type	Year	Key Feature
Baseline 3	Transformer	2022	BERT-based
Our Approach	Hybrid	2023	Attention + Context

4.2 Performance Results

4.2.1 Overall Performance

Main results across all datasets:

TABLE 4.3: Performance comparison on Dataset A

Method	Accuracy	Precision	Recall	F1-Score
Baseline 1	75.3%	0.74	0.72	0.73
Baseline 2	82.7%	0.81	0.80	0.80
Baseline 3	86.5%	0.85	0.84	0.84
Our Approach	**89.2%**	**0.88**	**0.87**	**0.88**

Our approach achieves the best performance across all metrics, with 2.7% improvement in accuracy over the strongest baseline (see Table 4.3).

4.2.2 Statistical Significance

Paired t-tests comparing our approach with baselines:

TABLE 4.4: Statistical significance ($\alpha = 0.05$)

Comparison	t-statistic	p-value	Significant?
Ours vs Baseline 1	8.42	< 0.001	Yes
Ours vs Baseline 2	5.15	< 0.01	Yes
Ours vs Baseline 3	2.87	< 0.05	Yes

4.3 Ablation Study

Component contribution analysis:

Table 4.5: Ablation study results

Model Variant	Accuracy	Change
Full Model	89.2%	-
Without Attention	85.1%	-4.1%
Without Pretraining	84.8%	-4.4%
Base Model Only	80.3%	-8.9%

The ablation study (Table 4.5) shows that both attention and pretraining are crucial components.

4.4 Per-Class Analysis

4.4.1 F1-Scores by Class

Table 4.6: Per-class F1-scores

Class	Baseline 1	Baseline 2	Baseline 3	Ours	Support
Class 1	0.78	0.84	0.88	**0.91**	2,450
Class 2	0.72	0.80	0.85	**0.87**	1,820
Class 3	0.70	0.79	0.84	**0.86**	1,650
Class 4	0.68	0.77	0.82	**0.84**	1,430
Class 5	0.74	0.82	0.86	**0.88**	1,710

4.5 Computational Efficiency

4.5.1 Resource Requirements

TABLE 4.7: Computational requirements

Method	Parameters	Training Time	Inference	Memory
Baseline 1	50K	5 min	0.1 ms	100 MB
Baseline 2	2.5M	45 min	1.5 ms	800 MB
Baseline 3	110M	240 min	6.0 ms	2.5 GB
Our Approach	15M	90 min	2.5 ms	1.2 GB

Our model (Table 4.7) achieves better accuracy than Baseline 3 while being:

- **2.7× faster** in inference
- **52% smaller** in memory footprint

4.6 Error Analysis

Common error patterns identified:

TABLE 4.8: Error distribution analysis

Error Type	Frequency	Example Case
Ambiguous context	35%	Context-dependent meaning
Rare patterns	28%	Infrequent class instances
Noisy input	22%	Misspellings, typos
Edge cases	15%	Boundary conditions

4.7 Discussion

Key findings:

1. **Performance**: Consistent improvements across all datasets (2-4% over baselines)
2. **Efficiency**: Good balance between accuracy and computational cost
3. **Components**: Both attention and pretraining contribute significantly
4. **Limitations**: Performance degrades on rare classes and ambiguous contexts

4.7.1 Comparison with Literature

Our results compare favorably with recent work:

- Similar accuracy to [1] with 40% fewer parameters
- Faster inference than transformer-based approaches [2]
- Better generalization across domains

4.8 Summary

Main findings from this chapter:

1. Proposed approach outperforms all baselines (Table 4.3)
2. Improvements are statistically significant (Table 4.4)
3. All components contribute to final performance (Table 4.5)
4. Efficient in terms of computational resources (Table 4.7)

The next chapter discusses implications and future work.

Chapter 5

Discussion

This chapter provides an in-depth discussion of the research findings.

5.1 Overview

Provide an overview of what will be discussed in this chapter.

5.2 Interpretation of Results

Interpret your results in the context of existing literature and theory.

5.3 Implications

Discuss the theoretical and practical implications of your research:

5.3.1 Theoretical Implications

How do your findings contribute to existing theory?

5.3.2 Practical Implications

What are the practical applications of your research?

5.4 Limitations

Acknowledge and discuss the limitations of your study.

5.5 Summary

Summarize the key discussion points.

Chapter 6

Conclusions and Future Work

This chapter concludes the thesis and suggests directions for future research.

6.1 Overview

Provide a brief overview of the conclusions drawn from this research.

6.2 Main Contributions

Summarize the main contributions of your research:

1. **Contribution 1**: Description of first contribution
2. **Contribution 2**: Description of second contribution
3. **Contribution 3**: Description of third contribution

6.3 Conclusions

Present the main conclusions of your research, addressing each research question posed in Chapter 1.

6.3.1 Research Question 1

State how your research answered the first research question.

6.3.2 Research Question 2

State how your research answered the second research question.

6.3.3 Research Question 3

State how your research answered the third research question.

6.4 Future Work

Suggest directions for future research:

- **Direction 1**: Describe potential extension or improvement
- **Direction 2**: Describe another research opportunity
- **Direction 3**: Describe additional future work

6.5 Closing Remarks

Provide final thoughts on the significance and impact of your research.

Chapter 7

Additional Contributions

This chapter presents additional contributions and supplementary work.

7.1 Overview

Provide context for the additional contributions presented in this chapter.

7.2 Additional Work

Describe any additional work that complements the main research.

7.3 Summary

Summarize the additional contributions.

List of Publications

This section lists the publications that resulted from this research.

Journal Articles

1. Author, A., Author, B. (Year). Title of the paper. *Journal Name*, Volume(Issue), pages. DOI

2. Author, A., Author, B. (Year). Title of another paper. *Journal Name*, Volume(Issue), pages. DOI

Conference Papers

1. Author, A., Author, B. (Year). Title of the conference paper. In *Proceedings of Conference Name* (pp. pages). Location: Publisher.

2. Author, A., Author, B. (Year). Title of another conference paper. In *Proceedings of Conference Name* (pp. pages). Location: Publisher.

Workshop Papers and Posters

1. Author, A., Author, B. (Year). Title of workshop paper. In *Workshop Name at Conference*, Location.

Replace this template content with your actual publications.

References

[1] J. Smith and J. Doe, “A sample research article on machine learning,” *Journal of Artificial Intelligence Research*, vol. 45, no. 3, pp. 123–145, 2023. DOI: 10.1234/jair.2023.0001

[2] A. Johnson and B. Williams, “Deep learning approaches for data analysis,” in *Proceedings of the International Conference on Machine Learning*, PMLR, 2022, pp. 456–468.

[3] C. Brown, *Fundamentals of Computer Science*. New York, NY: Academic Press, 2021.