# Curriculum

# For

# *3 Year Diploma of Associate Engineer*

# *In*

# *Artificial Intelligence (AI)*

**Approved By :-**
**Centre for Curriculum Research & Development**
**Sindh Board of Technical Education, Karachi**

# *Curriculum*

## *For*

## *3 Year Diploma of Associate Engineer*

## *In*

# *Artificial Intelligence (AI)*

**Eligibility: Minimum Matric**

**Duration: 3 Year**

# Certification:

# Sindh Board of Technical Education (SBTE)

| Scheme of Studies | | Page |
|---|---|---|
| **Syllabi** | **1st Year** | 6 |
| AI-101 | Python For Data Analytics & Wrangling | 40 |
| AI-102 | SQL For Data Analytics | 44 |
| AI-103 | Exploratory Data Analysis (EDA) | 49 |
| AI-104 | Data Handling & Visualization | 54 |
| | **2nd Year** | 58 |
| AI-201 | Computation Foundation For AI | 73 |
| AI-202 | Business Intelligence Insight Platform (BIIP) | 78 |
| AI-203 | AI Primer [ML, DL, Neural N/Ws] | 83 |
| AI-204 | Machine learning (ML) | 88 |
| AI-205 | Version Control Framework | 92 |
| | **3rd Year** | 95 |
| AI-301 | Cloud Providers (Emerging Technologies) | 112 |
| AI-302 | R Programming | 116 |
| AI-303 | Natural Language Processing | 121 |
| AI-304 | Deep Learning | 126 |
| AI-305 | Generative AI (GenAI) | 131 |
| AI-306 | Introduction To Blockchain | 134 |

## SCHEME OF STUDIES & EVALUATION PLAN FOR POST-MATRIC

## DIPLOMA IN ARTIFICIAL INTELLIGENCE (3-Year)

**First Year**

| Code | | Course Title | T | P | C |
|---|---|---|---|---|---|
| 1. | GEN-111 | Islamiat & Pak Studies | 1 | 0 | 1 |
| 2. | ENG-112 | English | 2 | 0 | 2 |
| 3. | MATH-123 | Mathematics-I | 3 | 0 | 3 |
| 4. | PHY-132 | Physics-I | 1 | 3 | 2 |
| 5. | CIT-113 | Introduction to Computer Programming | 1 | 3 | 2 |
| 6. | AI-101 | Python For Data Analytics & Wrangling | 1 | 3 | 2 |
| 7. | AI-102 | SQL For Data Analytics | 1 | 3 | 2 |
| 8. | AI-103 | Exploratory Data Analysis (EDA) | 1 | 3 | 2 |
| 9. | AI-104 | Data Handling & Visualization | 1 | 3 | 2 |
| 10. | AI-105 | Final Capstone Project I | - | 6 | 2 |
| | | Total | 12 | 24 | 20 |

**Second Year**

| Code | | Course Title | T | P | C |
|---|---|---|---|---|---|
| 1. | GEN-211 | Islamiat & Pak Studies | 1 | - | 1 |
| 2. | MGM-211 | Business Communication | 2 | - | 2 |
| 3. | MATH-233 | Mathematics-II | 3 | - | 3 |
| 4. | AI-201 | Computation Foundation for AI | 1 | 3 | 2 |
| 5. | AI-202 | Business Intelligence Insights Platform (BIIP) | 1 | 3 | 2 |
| 6. | AI-203 | AI Primer [ML, DL, Neural N/Ws] | 1 | 3 | 2 |
| 7. | AI-204 | Machine learning (ML) | 1 | 3 | 2 |
| 8. | AI-205 | Version Control Framework | 1 | 3 | 2 |
| 9. | AI-206 | Final Capstone Project II | - | 6 | 2 |
| | | Total | 11 | 21 | 18 |

**Third Year**

| Code | | Course Title | T | P | C |
|---|---|---|---|---|---|
| 1. | GEN-311 | Islamiat & Pak Studies | 1 | 0 | 1 |
| 2. | MGT-331 | Management | 1 | 0 | 1 |
| 3. | ENG-311 | Technical Report Writing | 1 | 0 | 1 |
| 4. | AI-301 | Cloud Providers (Emerging Technologies) | 1 | 3 | 2 |
| 5. | AI-302 | R Programming | 1 | 3 | 2 |
| 6. | AI-303 | Natural Language Processing | 1 | 3 | 2 |
| 7. | AI-304 | Deep Learning | 1 | 3 | 2 |
| 8. | AI-305 | Generative AI (GenAI) | 1 | 3 | 2 |
| 9. | AI-306 | Introduction to Blockchain | 1 | 3 | 2 |
| 10. | AI-307 | Final Capstone Project III | - | 6 | 2 |
| | | Total | 9 | 24 | 17 |

# SYLLABI

# DAE IN ARTIFICIAL INTELLIGENCE

# FIRST YEAR

| | | T | P | C |
|---|---|---|---|---|
| COURSE CODE: | **GEN-111** | | | |
| COURSE TITLE: | **Islamiat / Pak Studies** | **1** | **0** | **1** |

یہ کورس طلباء کو اسلامیات اور مطالعہ پاکستان کے بنیادی اصولوں اور تصورات سے روشناس کراتا ہے۔ اس کا مقصد طلباء میں دینی اور قومی شعور کو اجاگر کرنا اور انہیں ملک کے نظریاتی اور تاریخی پس منظر سے واقف کرانا ہے۔

**COURSE OBJECTIVE:** **کورس کے متوقع مقاصد**

**1. قرآن مجید**

- عمومی مقصد: طالب علم یہ سمجھے کے بقائے ہولکہ اسلام کی تعلیمات کا اصل سرچشمہ قرآن مجید ہے جس میں نہ تحریف، نہ باطل کا دخل ہو سکتا ہے اور نہ تغیر کا۔
  - قرآن مجید کی تعریف کر سکے کا
  - قرآن مجید کے نزول کی صورت بیان کر سکے
  - قرآن مجید کی دو عملی سورتوں کی پہچان کر سکے
  - اللہ سے قرآنی دعا و تلقین کر سکے
  - عمومی مقاصد: سمجھنے کے قابل ہونے کے کار تحت قرآن کی آیات کے ذریعے اسلامی اِصطلاحات کا مفہوم کر لے
  - قرآن کی آیات، تعبیر، تشریح کر لے
  - قرآنی تعلیمات کی روشنی میں اِفری اور معاشرتی اصلاح کر سکے

**2. سنت**

- عمومی مقصد: طالب علم سنت نبوی کی اہمیت اور ضرورت کو اچھی طرح سمجھ کے غرض ہو جائے گا
- خصوصی مقاصد
  - سنت کی تعریف بیان کر سکے
  - سنت کی اہمیت و صرورت کو وضاحت کر سکے
  - سنت کی روشنی میں اُسوہ حسنہ پر عمل کر سکے

**3. فقہ اسلامی**

- عمومی مقصد: اِسلامی کی روشنی میں اِخلاقی اقدار سے آگہی حاصل کر لے
- خصوصی مقصد:
  - اِصلاحات کا رمز و تشریع کر لے
  - اِسلامی آقدار کے اِنسانی معاشرتی زندگی پر آثرات

**4- دینِ اِسلام**

- عمومی مقاصد: دینِ اسلام کے بنیادی مقاصد اور عبادات کے بارے میں جان سکے اور بیان کر سکے
- خصوصی مقاصد:
  - لفظ دین اسلام کے لغوی اور اِصطلاحی معنی بیان کر سکے
  - اسلام کے بنیادی مقاصد کی آہمیت بیان کر سکے
  - اسلام کے بنیادی مقاصد سے اِنسان کی اِفرادی اور اِجتماعی زندگی پر پڑنے والے آثرات بیان کر سکے
  - عبادت کے لغوی اور اِصطلاحی معنی بیان کر سکے
  - عقیدے اور عبادت کا فرق بیان کر سکے
  - عبادات (نماز، روزہ، حج، زکٰوۃ) کے فوری آحکامات اور مثالی زندگی پر اِن کی آثرات بیان کر سکے
  - اِسلامی مقاصد و عبادات کے مطابق اپنی زندگی کی ڈھال کر ایک اچھا مسلمان بن سک

**COURSE DURATION:** **کورس کی مدت**

| | | |
|---|---|---|
| Theory | 32 hours | one hour per week |

نظریاتی (Theory): بتیس )۳۲( گھنٹے (فی ہفتہ ایک گھنٹہ)

**SYLLABUS (Topics: Part I Islamic Studies)** **موضوعات حصہ اول اسلامیات**

## (The Quran and Sunnah) کتاب و سنت

### (The Holy Quran) ا) قرآن مجید

1. تعارف قرآن مجید 2. (Introduction to the Holy Quran)
نزول قرآن (Revelation)
3. مکی و مدنی سورتوں کی خصوصیات 4. (Characteristics of Makki and Madani Surahs)
وحی کی اقسام (Types of Revelation)
5. چند/کچھ منتخب آیات مع ترجمہ (A few/Some Selected Verses with Translation)

5.1 تَنَالُوا الْبِرَّ حَتَّى تُنْفِقُوا مِمَّا تُحِبُّونَ
5.2 وَاعْتَصِمُوا بِحَبْلِ اللّٰهِ جَمِيعًا وَّ لَا تَفَرَّقُوا 5.3 وَلَا يَجْرِمَنَّكُمْ شَنَآنُ قَوْمٍ عَلٰى اَلَّا تَعْدِلُوا
5.4 إِنَّ اللّٰهَ يَأْمُرُكُمْ أَن تُؤَدُّوا الْأَمَانَاتِ إِلَى أَهْلِهَا 5.5 إِنَّ اللّٰهَ يَأْمُرُ بِالْعَدْلِ وَالْإِحْسَانِ
5.6 إِنَّ الصَّلٰوةَ تَنْهٰى عَنِ الْفَحْشَآءِ وَالْمُنْكَرِ 5.7
لَقَدْ كَانَ لَكُمْ فِي رَسُولِ اللّٰهِ أُسْوَةٌ حَسَنَةٌ 5.8
إِنَّ أَكْرَمَكُمْ عِنْدَ اللّٰهِ أَتْقَاكُمْ
5.9 وَمَا آتَاكُمُ الرَّسُولُ فَخُذُوهُ وَمَا نَهَاكُمْ عَنْهُ فَانتَهُوا 5.10
وَلَوْفُوا بِالْعَهْدِ
5.11 وَعَاشِرُوهُنَّ بِالْمَعْرُوفِ
5.12 يَمْحَقُ اللّٰهُ الرِّبٰوا وَيُرْبِي الصَّدَقَاتِ
5.13 وَاصْبِرْ عَلٰى مَآ أَصَابَكَ
5.14 وَقُولُوا قَوْلًا سَدِيدًا 5.15
إِنَّ الدِّينَ عِندَ اللّٰهِ الْإِسْلَامُ

### (The Sunnah) (ب) سنت

1. سنت کی اہمیت (Importance of Sunnah)
2. دس منتخب احادیث مع ترجمہ و تشریح (Ten Selected Ahadith with Translation and Explanation)

إِنَّمَا الْأَعْمَالُ بِالنِّيَّاتِ أُكْمِلَتْ
لَكُمْ مَكَارِمَ الْأَخْلَاقِ
لَايُؤْمِنُ أَحَدُكُمْ حَتَّى يُحِبَّ لِأَخِيهِ مَا يُحِبُّ لِنَفْسِهِ
الْمُسْلِمُ مَنْ سَلِمَ الْمُسْلِمُونَ مِنْ لِسَانِهِ وَيَدِهِ فِي أُمِّتِي بِاللهِ مَا سَلِمَ أَسْتَغْفِرُهُ
دُبٍّ خَيْرٍ كَمَا
قَالَ
سِبَابُ الْمُسْلِمِ فُسُوقٌ وَقِتَالُهُ كُفْرٌ
الْمُؤْمِنُونَ إِخْوَةٌ

1. عَلَى الْمُسْلِمِ حَرَامٌ دَمُهُ وَمَالُهُ وَعِرْضُهُ
2. أَ يَةُ الْمُنَافِقِ ثَلَاثَةٌ إِذَا حَدَّثَ كَذَبَ وَإِذَا وَعَدَ أَخْلَفَ وَإِذَا اؤْتُمِنَ خَانَ
3.
4.
5.
6.
7.
8.
9.
10.

**دینِ اِسلام**

11. اِسلام کے بنیادی شعبے ،ن وَضاحت اور اِنسان کی اِفرادی و اِجتماعی زندگی پر اِن کے آثرات
    a. توحید
    b. رسالت
    c. آخرت
    d. ملائکہ
    e. اِہلِ کِتاب
12. عبادات
    a. نماز، روزہ، زکٰوۃ اور حج
    b. مذکورہ بالا آرکان کی آہمیت و فضیلت، حکمتیں اور اِنسان کی اِفرادی و معاشرتی زندگی پر اِن کے آثرات

| | | T | P | C |
|---|---|---|---|---|
| COURSE CODE: | **GEN-111 (For Non-Muslims)** | | | |
| COURSE TITLE: | **Islamiat / Pak Studies (For Non-Muslims)** | **1** | **0** | **1** |

یہ کورس طلباء کو اسلامیات اور مطالعہ پاکستان کے بنیادی اصولوں اور تصورات سے روشناس کراتا ہے۔ اس کا مقصد طلباء میں اخلاقی اور قومی شعور کو اجاگر کرنا اور انہیں ملک کے نظریاتی اور تاریخی پس منظر سے واقف کرانا ہے۔

**COURSE OBJECTIVE:** **کورس کے متوقع مقاصد**

**تذھیب اخلاقیات**

**(عملی نُز) تدریسی مقاصد**

- عمومی مقاصد: اعلٰی اِخلاق کی آدل و عملی خصلتوں میں تقبل قدر و تمیز کر سکے
- خصوصی مقاصد: طالب علم میں علم سے اِس عمل ہو گا۔
  - ہر موضوعات کا طالب بیان کر سکے
  - عملی زندگی سے مثالوں کی نشاندہی کر سکے
  - اپنی شخصیت اور معاشرے پر ہر موضوعات کے مثبت آثرات پیدا اکرنے کے طریقے جان کر سکے
  - راستہ اِرادی کی آہمیت بیان کر سکے
  - وفاداری کی اہمیت بیان کر سکے
  - عزم و جزم کی تقویت بیان کر سکے
  - صداقت کی ضرورت بیان کر سکے
  - حوصلہ مندی کے فوائد بیان کر سکے
  - مروت کی پابندی کے فوائد بیان کر سکے
  - متفق اور باہمی اِعتبار سے حسن کارکردگی کو بیان کر سکے
  - مصلحت کے فوائد بیان کر سکے

**COURSE DURATION:** **کورس کی مدت**

| | | |
|---|---|---|
| Theory | 32 hours | one hour per week |

نظریاتی (Theory): بتیس )۳۲( گھنٹے (فی ہفتہ ایک گھنٹہ)

## حصہ دوم مطالعہ پاکستان

**کورس کے متوقع مقاصد** **COURSE OBJECTIVE:**

★ عمومی مقصد:طالب علم یہ جان سکے کہ اسلام میں مسلمان قوم میں آزادی فکری کی اہمیت کیوں ہے۔ ★
خصوصی مقاصد:

- حریتِ فکر کا صحیح مفہوم بیان کر سکے
- آزادی فکری کی اہمیت بیان کر سکے
- خصوصیت اسلام میں جُھولی اِخلاقیات کی اہمیت بیان کر سکے
- ذہنی غلامی کے قومی سطح پر نقصانات کے بیان کر سکے
- جسمانی غلامی کے قومی سطح پر نقصانات بیان کر سکے

★ **نظریۂ پاکستان**

- عمومی مقصد: نظریۂ پاکستان (دینِ اسلام) سے پوری طرح واقفیت ہو جائے
- خصوصی مقاصد:
  - دو قومی نظریہ کی تعریف بیان کر سکے اور اس کی وضاحت کر سکے
  - نظریۂ پاکستان کی تعریف کر سکے اور اس کا مفہوم بیان کر سکے
  - علامہ اقبال اور قائد اعظم کے فرمودات کی روشنی میں نظریۂ پاکستان بیان کر سکے

★ **نظریۂ پاکستان کا تاریخی پہلو**

- عمومی مقصد: نظریۂ پاکستان کے تاریخی پس منظر سے واقفیت حاصل کر سکے
- خصوصی مقاصد:
  - محمد بن قاسم کی آمد کے بارے میں بیان کر سکے
  - محمد بن قاسم کے ہندوستان پر حملے کی وجوہات بیان کر سکے
  - محمد بن قاسم کے ہندوستان پر حملے کے اثرات بیان کر سکے
  - بیان کر سکے کہ ہندوستان میں دو قومی نظریہ کو کیو نکر ابھارنا ہے
  - مجدد الف ثانی کی علمی خدمات بیان کر سکے
  - شاہ ولی اللہ کی علمی خدمات بیان کر سکے
  - محمد بن قاسم اور شاہ ولی اللہ کی دو سیاسی اور تعلیمی محرکات بھی ضروری ہیں بیان کر سکے

- **علمی تحریکیں**
  - عمومی مقصد: برصغیر میں علمی تحریکوں سے اچھی طرح واقفیت حاصل ہو جائے
  - خصوصی مقصد:
    - علی گڑھ، دیوبند، دارالعلوم، اسلامی کالج، انجمن حمایت اسلام (لاہور) کے تعلیم کے ذریعے سیاسی شعور مسلمانوں میں پیدا آیا ہے بیان کر سکے
    - آزادی کے ساتھ ملک میں تحریک چلانے کی خدمات بیان کر سکے

## SYLLABUS (Topics: Part II Pakistan Studies) موضوعات حصہ دوم: مطالعہ پاکستان

❖ **حریتِ فکر**

مسلمان قوم میں آزادیِ فکر کی تاریخ، مسلمانوں میں سیاسی آزادی کی اہمیت اور ضرورت، ذہنی اور جسمانی غلامی کے نقصانات

❖ **نظریۂ پاکستان**

قیامِ پاکستان کی اساس (دینِ اسلام)۔ قیامِ پاکستان کے اغراض و مقاصد۔ نظریۂ پاکستان کی وضاحت۔ نظریۂ پاکستان اور دو قومی نظریہ (علامہ اقبال اور قائد اعظم کی تقاریر کی روشنی میں)۔

❖ **نظریۂ پاکستان کا تاریخی پہلو**

محمد بن قاسم کی آمد (برصغیر میں اسلامی اثرات کا آغاز)، جدد الف ثانی اور شاہ ولی اللہ کی خدمات (دینی اور فکری اصلاحات)، سرسید احمد خان کی تحریکِ مجاہدین

❖ **تعلیمی تحریکیں**

علی گڑھ (تحریکِ علی گڑھ) ۔ دارالعلوم دیوبند۔ مدرسۃ العلوم ۔ اسلامیہ کالج پشاور۔ مدرسۃ الاسلام (سندھ)۔ انجمن حمایتِ اسلام (لاہور)

| | | T | P | C |
|---|---|---|---|---|
| COURSE CODE: | **ENG-112** | | | |
| COURSE TITLE: | **ENGLISH** | **2** | **0** | **2** |

At the end of the course, the students will be equipped with cognitive skills to enable them to present facts in a systematic and logical manner to meet the language demands of the dynamic field of commerce and industry for functional day-to-day use and will inculcate skills of reading, writing and comprehension.

## COURSE OBJECTIVE:

**ENGLISH PAPER 'A'**

1. DEMONSTRATE BETTER READING, COMPREHENSION AND VOCABULARY
   1.1 Manipulate, skimming and scanning of the text.
   1.2 Identify new ideas.
   1.3 Reproduce facts, characters in own words
   1.4 Write summary of stories
2. UNDERSTAND FACTS OF THE TEXT
   2.1 Rewrite words to fill in the blanks recalling the text.
   2.2 Use your own words to fill in the blanks.

**ENGLISH PAPER 'B'**

3. APPLY THE RULES OF GRAMMAR IN WRITING AND SPEAKING
   3.1 Use rules of grammar to construct meaningful sentences containing a subject and a predicate.
   3.2 State classification of time, i.e. present, past and future and use verb tense correctly in different forms to denote relevant time.
   3.3 Identify function words and content words.
   3.4 Use punctuation marks to make sense.
   3.5 Relate what a person says in direct and indirect forms.
   3.6 Compose his writings.
   3.7 Distinguish between confusing words.

4. APPLY THE CONCEPTS OF COMPOSITION WRITING TO PRACTICAL SITUATIONS

4.1 Use concepts to construct applications for employment, for character certificate, for grant of scholarship.

4.2 Define and write telegrams, cablegrams and radiograms, telexes, facsimiles

4.3 Describe steps of good composition writing.

4.4 Describe features of a good composition.

4.5 Describe methods of composition writing

4.6 Use these concepts to organize facts and describe them systematically in practical situations.

5. APPLY RULES OF TRANSLATION

5.1 Describe confusion.

5.2 Describe rules of translation.

5.3 Use rules of translation from Urdu to English in simple paragraphs and sentences.

# COURSE OUTLINE

| Contents | Hours |
|---|---|

**ENGLISH PAPER 'A'**

1. 1 PROSE/TEXT — 16 hours

    1.1 First eight essays of Intermediate English Book-II

2. CLOZE TEST — 4 hours

    2.1 A passage comprising 50-100 words will be selected from the text. Every 11th word or any word for that matter will be omitted. The number of missing words will range between 5-10. The chosen word may or may not be the one used in the text, but it should be an appropriate word.

**ENGLISH PAPER 'B'**

3. GRAMMAR — 26 hours

    3.1 Sentence Structure.
    3.2 Tenses.
    3.3 Parts of speech.
    3.4 Punctuation.
    3.5 Change of Narration.
    3.6 One word for several
    3.7 Words often confused

4. COMPOSITION — 8 hours

    4.1 Letters/Messages
    4.2 Job application letter
    4.3 For character certificate/for grant of scholarship
    4.4 Telegrams, Cablegrams and Radiograms, Telexes, Facsimiles
    4.5 Essay writing
    4.6 Technical Education, Science and Our life, Computers, Environmental Pollution, Duties of a Student.

5. TRANSLATION — 10 hours

    5.1 Translation from Urdu into English.
    For Foreign Students: A paragraph or a dialogue.

## RECOMMENDED BOOKS

1. Intermediate English Book-II.
2. An English Grammar and Composition of Intermediate Level.
3. A Hand Book of English Students By Gatherer.

COURSE CODE**: MATH 123**
COURSE TITLE**: APPLIED MATHEMATICS-I**

| T | P | C |
|---|---|---|
| 2 | 0 | 2 |

**Pre-requisite:** Must have completed a course of Elective Mathematics at Matric level.

**AIMS:** After completing the course the students will be able to:

1. Solve problems of Algebra, Trigonometry, vectors, Mensuration, Matrices and Determinants.

2. Develop skill, mathematical attitudes and logical perception in the use of mathematical instruments as required in the technological fields.

3. Acquire mathematical clarity and insight in the solution of technical problems.

## INSTRUCTIONAL OBJECTIVES

### 1. USE DIFFERENT METHODS FOR THE SOLUTION OF QUADRATIC EQUATION

1.1 Define a standard quadratic equation.
1.2 Use methods of factorization and method of completing the square for solving the equations.
1.3 Derive quadratic formula.
1.4 Write an expression for the discriminant.
1.5 Explain the nature of the roots of a quadratic equation.
1.6 Calculate the sum and product of the roots.
1.7 Form a quadratic equation from the given roots.
1.8 Solve problems involving quadratic equations.

### 2. APPLY BINOMIAL THEOREM FOR THE EXPANSION OF BINOMIAL AND EXTRACTION OF ROOTS.

2.1 State binomial theorem for positive integral index.
2.2 Explain binomial coefficients:
(n,0), (n,1) (n,r) , (n,n)
2.3 Derive expression for the general term.
2.4 Calculate the specified terms.
2.5 Expand a binomial of a given index.
2.6 Extract the specified roots.
2.7 Compute the approximate value to a given decimal place.
2.8 Solve problems involving binomials.

**3. APPLY DIFFERENT METHODS FOR RESOLVING A SINGLE FRACTION INTO PARTIAL FRACTIONS USING DIFFERENT METHODS**

3.1 Define a partial fraction, a proper and an improper fraction.
3.2 Explain all the four types of partial fractions.
3.3 Set up equivalent partial fractions for each type.
3.4 Explain the methods for finding constants involved.
3.5 Resolve a single fraction into partial fractions.
3.6 Solve problems involving all the four types.

**4. UNDERSTAND THE SYSTEMS OF MEASUREMENT OF ANGLES.**

4.1 Define angles and the related terms.
4.2 Illustrate the generation of an angle.
4.3 Explain sexagesimal and circular systems for the measurement of angles.
4.4 Derive the relationship between radian and degree.
4.5 Convert radians to degrees and vice versa.
4.6 Derive a formula for the circular measure of a central angle.
4.7 Use this formula for solving problems.

**5. UNDERSTAND BASIC CONCEPTS AND PRINCIPLES OF TRIGONOMETRIC FUNCTIONS.**

5.1 Define the basic trigonometric functions/ratios of an angle as ratios of the sides of a right triangle.
5.2 Derive fundamental identities.
5.3 Find trigonometric ratios of particular angles.
5.4 Draw the graph of trigonometric functions.
5.5 Solve problems involving trigonometric functions.

**6. USE TRIGONOMETRIC IDENTITIES IN SOLVING TECHNOLOGICAL PROBLEMS**.

6.1 List fundamental identities.
6.2 Prove the fundamental law.
6.3 Deduce important results.
6.4 Derive sum and difference formulas.
6.5 Establish half angle, double and triple angle formulas.
6.6 Convert sum or difference into product and vice versa.
6.7 Solve problems.

**7. USE CONCEPT, PROPERTIES AND LAWS OF TRIGONOMETRIC FUNCTIONS FOR SOLVING TRIANGLES.**

7.1 Define angle of elevation and angle of depression.
7.2 Prove the law of sines and the law of cosines.
7.3 Explain elements of a triangle.
7.4 Solve triangles and the problems involving heights and distances.

**8. UNDERSTAND PRINCIPLES OF VECTORS AND PHASORS**

8.1 Define unit vectors i, j, k.
8.2 Express a vector in the component form.
8.3 Explain magnitude, unit vector, direction cosines of a vector.
8.4 Explain dot product and cross product of two vector.
8.5 Deduce important results from dot and cross product.
8.6 Define phasor and operator j.
8.7 Explain different forms of phasors.
8.8 Perform basic Algebraic operation on phasors.
8.9 Solve problems on phasors.

**9. USE PRINCIPLES OF COMPLEX NUMBERS IN SOLVING TECHNOLOGICAL PROBLEMS.**

9.1 Define a complex number and its conjugate.
9.2 State properties of complex numbers.
9.3 Give different forms of complex numbers.
9.4 Perform basic algebraic operations on complex numbers.
9.5 Solve problems involving complex numbers.

**10. SOLVE TECHNICAL PROBLEMS USING PRINCIPLES OF BOOLEAN ALGEBRA**

10.1 Explain fundamental concepts of Boolean algebra
10.2 Explain binary numbers, octal numbers, decimal numbers and their interconversion.
10.3 Explain digital addition and multiplication and its applications to OR gates and AND Gates
10.4 Illustrate complementation and inversion
10.5 Evaluate logical expression
10.6 List basic Laws of Boolean Algebra
10.7 Explain De-Morgan's theorem
10.8 Explain basic duality of Boolean algebra
10.9 Derive Boolean expression

10.10 Explain combination of GATES
10.11 Illustrate sum of products and product of sum
10.12 Derive product of sum expression
10.13 Explain NAND Gates and NOR Gates
10.14 Use the map methods for simplifying expressions
10.15 Explain sub-cubes and covering

## 11. UNDERSTAND THE CONCEPT OF PLANE ANALYTIC GEOMETRY

11.1 Explain the rectangular coordinate system.
11.2 Locate points in different quadrants.
11.3 Derive distance formula.
11.4 Describe the ratio formula
11.5 Derive slope formula
11.6 Solve problems using the above formulae.

## 12. USE EQUATIONS OF STRAIGHT LINE IN SOLVING PROBLEMS.

12.1 Define equation of a straight line.
12.2 Derive slope intercept and intercept forms of equations of a straight line.
12.3 Write a general form of equations of a straight line.
12.4 Derive an expression for the angle between two straight lines.
12.5 Derive conditions of perpendicularity and parallelism of two straight lines.
12.6 Solve problems using these equations/formulae.

## 13. SOLVE TECHNOLOGICAL PROBLEMS USING EQUATIONS OF CIRCLE

13.1 Define a circle.
13.2 Describe standard, central and general forms of the equation of a circle.
13.3 Convert general form to the central form of the equation of a circle.
13.4 Deduce formula for radius and coordinates of the center of a circle.
13.5 Derive equation of the circle passing through three points.
13.6 Solve problems involving these equations.

# COURSE CONTENTS

**1. QUADRATIC EQUATIONS** **6 Hours**

1.1 Standard Form
1.2 Solution
1.3 Nature of roots
1.4 Sum & Product of roots
1.5 Formation
1.6 Problems

**2. BINOMIAL THEOREM** **6 Hours**

2.1 Factorials
2.2 Binomial Expression
2.3 Binomial Co-efficient
2.4 Statement
2.5 The General Term
2.6 The Binomial Series
2.7 Problems.

**3. PARTIAL FRACTIONS** **6 Hours**

3.1 Introduction
3.2 Linear Distinct Factors Case I
3.3 Linear Repeated Factors Case II
3.4 Quadratic Distinct Factors Case III
3.5 Quadratic Repeated Factors Case IV
3.6 Problems

**4. FUNDAMENTALS OF TRIGONOMETRY** **6 Hours**

4.1 Angles
4.2 Quadrants
4.3 Measurements of Angles
4.4 Relation between Sexagesimal & circular system
4.5 Relation between Length of a Circular Arc & the Radian Measure of its central Angle
4.6 Problems

**5. TRIGONOMETRIC FUNCTIONS AND RATIOS** **6 Hours**

5.1 Trigonometric functions of any angle
5.2 Signs of trigonometric Functions
5.3 Trigonometric Ratios of particular Angles
5.4 Fundamental Identities
5.5 Problems

**6. GENERAL IDENTITIES** **6 Hours**

6.1 The Fundamental Law
6.2 Deductions
6.3 Sum & Difference Formulae
6.4 Double Angle Identities
6.5 Half Angle Identities
6.6 Conversion of sum or difference to products
6.7 Problems

**7. SOLUTION OF TRIANGLES** **6 Hours**

7.1 The law of Sines
7.2 The law of Cosines
7.3 Measurement of Heights & Distances
7.4 Problems

**8. VECTORS AND PHASORS** **12 Hours**

8.1 Scalars and Vectors
8.2 The unit Vectors i, j, k
8.3 Direction Cosines
8.4 Dot Product
8.5 Cross Product
8.6 Analytic Expressions for dot and cross products
8.7 Phasors
8.8 Significance of j Operator
8.9 Different Forms
8.10 Algebraic Operations
8.11 Problems

**9. COMPLEX NUMBERS** **9 Hours**

9.1 Introduction and Properties
9.2 Basic Operations
9.3 Conjugate
9.4 Modulus
9.5 Different Forms
9.6 Problems

**10. BOOLEAN ALGEBRA AND GATE NETWORKS** **15 Hours**

10.1 Concept and basic laws
10.2 Sums of product and products of sums
10.3 Binary, decimals and octals, presentation of decimal numbers in BCD
10.4 Interconversion of numbers
10.5 OR Gates and AND Gates
10.6 Logical Expressions and their simplifications
10.7 Demorgan's Theorems
10.8 NAND Gates and NOR Gates
10.9 Problems

**11. PLANE ANALYTIC GEOMETRY AND STRAIGHT LINE** **6 Hours**

11.1 Coordinate system
11.2 Distance formula
11.3 Ration Formulas
11.4 Inclination and slope of line
11.5 Slope Formula
11.6 Problems

**12. EQUATIONS OF THE STRAIGHT LINE** **6 Hours**

12.1 Some Important Forms
12.2 General form
12.3 Angle Formula
12.4 Parallelism and Perpendicularity
12.5 Problems

**13. EQUATIONS OF THE CIRCLE** **6 Hours**

13.1 Standard and Central forms of equations
13.2 General Form of Equation
13.3 Radius and Coordinates of Center
13.4 Problems

**RECOMMENDED BOOKS**

1. Ghulam Yasin Minhas, Technical Mathematics Vol I, Ilmi Kitab Khana, Lahore
2. Riaz Ali Khan, Polytechnic Mathematics Series Vol- I and Vol -II, Majeed Sons, Faisalabad.
3. Sana Ullah Bhatti, A Text Book of Algebra and Trigonometry, Punjab Text Book Board, Lahore
4. Sana Ullah Bhatti, A Text Book of Analytic Geometry and Calculus, Punjab Text Book Board, Lahore

COURSE CODE**: PHY 132**
COURSE TITLE**: APPLIED PHYSICS-I**

| T | P | C |
|---|---|---|
| 2 | 0 | 2 |

**Total Contact Hours:**

- **Theory: 32**
- **Practical: 96**

**Aims:**

The students will be able to understand the fundamental principles and concepts of Physics, use these to solve problems in practical situations/technological courses and understand concepts to learn advanced Physics/technical courses.

## Instructional Objectives

**1. Use concepts of measurement to practical situations and technological problems**

1.1 Write dimensional formulae for physical quantities.
1.2 Derive units using dimensional equations.
1.3 Convert a measurement from one system to another.
1.4 Use concepts of measurement and significant figures in problem solving.

**2. Use concepts of scalars and vectors in solving problems involving these concepts**

2.1 Explain laws of parallelogram, triangle and polygon of forces.
2.2 Describe the method of resolution of a vector into components.
2.3 Describe the method of addition of vectors by rectangular components.
2.4 Differentiate between dot product and cross product of vectors.
2.5 Use the concepts in solving problems involving addition resolution and multiplication of vectors.

**3. Use the law of conservation of momentum and concepts of angular motion to practical situations**

3.1 Use the law of conservation of momentum to solve practical/technological problems.
3.2 Explain the relation between linear and angular motion.
3.3 Use concepts and equations of angular motion to solve relevant technological problems.

**4. Use concepts of torque, equilibrium and rotational inertia to practical situation/problems**

4.1 Explain Torque.
4.2 Distinguish between Centre of gravity and centre of mass.
4.3 Explain rotational equilibrium and its conditions.
4.4 Explain rotational inertia giving examples.
4.5 Use the above concepts in solving technological problems.

**5. Understand concepts of sound**

5.1 Describe longitudinal waves and its propagation.
5.2 Explain the concepts: Intensity, loudness, pitch and quality of sound.
5.3 Explain units of intensity of level and frequency response of ear.
5.4 Explain phenomena of silence zones, beats.
5.5 Explain acoustics of buildings.
5.6 Explain Doppler's Effect giving mathematical expressions.

**6. Use the concepts of geometrical optics to mirrors and lenses**

6.1 Explain laws of reflection and refraction.
6.2 Use a mirror formula to solve problems.
6.3 Use the concepts of image formation by mirrors and lenses to describe working of optical instruments, e.g. microscope, telescopes, camera and sextant.

**7. Understand wave theory of light**

7.1 Explain wave theory of light.
7.2 Explain phenomena of interference, diffraction, polarization of light waves.
7.3 Describe uses of polarization given in the course contents.

**8. Understand the structure, working and uses of optical fiber**

8.1 Explain the structure of the optical fiber.
8.2 Explain its principles of working.
8.3 Describe use of optical fiber in industry and medicine.

**9. Understand the structure, working and uses of lasers**

9.1 Explain the stimulated emission of radiation.
9.2 Explain the laser principle.
9.3 Describe the structure and working of lasers.
9.4 Distinguish between types of laser.
9.5 Describe the applications of lasers in the fields mentioned in the courses contents.

**10. Understand nature, types, generation and spectrum of electromagnetic waves**

10.1 Explain magnetic field due to current and electric field due to changing magnetic flux.
10.2 Explain moving fields.
10.3 Describe types of electromagnetic waves.
10.4 Explain generation of radio waves
10.5 Explain the spectrum of electromagnetic waves.

**11. Understand types and uses of artificial satellites**

11.1 Explain escape velocity.

11.2 Explain orbital velocity.

11.3 Distinguish between geosynchronous and geostationary satellites.

11.4 Describe uses of artificial satellites in data communication.

## Course Contents

| Course Contents | Hours |
|---|---|
| **1. Measurements** | **02** |
| 1.1. Fundamental units and derived units<br>1.2. Systems of measurement and S.I. units<br>1.3. Concept of dimensions, dimensional formula<br>1.4. Conversion from one system to another<br>1.5. Significant figures | |
| **2. Scalars and Vectors** | **04** |
| 2.1. Revision of head to tail rule<br>2.2. Laws of parallelogram, triangle and polygon of forces<br>2.3. Resolution of a vectors by rectangular components<br>2.4. Multiplication of two vectors, dot product and cross product | |
| **3. Motion** | **04** |
| 3.1. Review of laws and equations of motion<br>3.2. Law of conservation of momentum<br>3.3. Angular motion<br>3.4. Relation between linear and angular motion<br>3.5. Centripetal acceleration and force<br>3.6. Equations of angular motion | |
| **4. Torque, Equilibrium and rotational inertia** | **04** |
| 4.1. Torque<br>4.2. Centre of gravity and centre of mass<br>4.3. Equilibrium and its conditions<br>4.4. Torque and angular acceleration<br>4.5. Rotational inertia | |

**5. Sound** **06**

5.1. Longitudinal waves
5.2. Intensity, loudness, pitch and quality of sound
5.3. Units of intensity of level and frequency response of ear
5.4. Interference of sound waves silence zones, beats
5.5. Acoustics
5.6. Doppler effect

**6. Light** **06**

6.1 Review laws of reflection and refraction
6.2 Image formation by mirrors and lenses
6.3 Optical instruments
6.4 Waves theory of light
6.5 Interference, diffraction, polarization of light waves
6.6 Applications of polarization in sunglasses, optical activity and stress analysis

**7. Optical Fiber** **02**

7.1 Optical communication and problems
7.2 Review total internal reflection and critical angle
7.3 Structure of optical fiber
7.4 Fiber material and manufacture
7.5 Optical fiber – uses

**8. Lasers** **03**

8.1 Corpuscular theory of light
8.2. Emission and absorption of light
8.3. Stimulated absorption and emission of light
8.4. Laser principles
8.5. Structure and working of lasers
8.6. Types of lasers with brief description
8.7. Applications (Basic concepts)
8.8. Material processing
8.9. Laser welding
8.10. Laser assisted machining
8.11. Micro machining
8.12. Drilling, scribing and marking
8.13. Printing
8.14. Lasers in medicine

**9. Electromagnetic waves** **03**

9.1. Magnetic field around a current carrying conductor
9.2. Electric field induced around a changing magnetic flux
9.3. Moving fields
9.4. Types of electromagnetic waves
9.5. Generation of Radio waves
9.6. Spectrum of electromagnetic waves

**10. Artificial Satellites** **02**

10.1 Review law of gravitation
10.2 Escape velocity
10.3 Orbital velocity
10.4 Geosynchronous and geostationary satellites
10.5 Use of satellites in data communication

**Recommended Books:**

1. Tahir Hussain, Fundamentals of Physics Vol. – I and II
2. FaridKhawaja, Fundamental of Physics Vol. – I and II
3. Wells and Slusher, Schaum's Services Physics
4. Nelkon and Oyborn, Advanced Level Practical Physics
5. MehboobIllahi Malik and Inam-ulHaq, Practical physics
6. Wilson, Lasers – Principles and Applications
7. M. Aslam Khan and M. AkramSandhu, Experimental Physics Note Book

# LIST OF PRACTICALS

1. Draw graphs representing the functions:

    1.1. Y=mx for m=0, 0.5, 1,2
    1.2. $Y=x^2$
    1.3. Y=1/x

2. Find the volume of a given solid cylinder using Vernier calipers.

3. Find the area of cross-section of the given wire using a micrometer screw gauge.

4. Proven that force is directly proportional to (a) mass, (b) acceleration, using Fletcher's trolley.

5. Verify law of parallelogram of forces using Grave-sands apparatus.

6. Verify law of triangle of forces and Lami's theorem.

7. Determine the weight of a given body using:

    7.1. Law of parallelogram of forces.
    7.2. Law of triangle of forces.
    7.3. Lami's theorem.

8. Verify law op polygon of forces using grave-sands apparatus.

9. Locate the position and magnitude of resultant of like parallel forces.

10. Determine the resultant of two unlike parallel forces.

11. Find the weight of a given body using the principle of moments.

12. Locate the centre of gravity of regular and irregular shaped bodies.

13. Find Young's Modules of Elasticity of a metallic wire.

14. Verify Hooke's Law using helical springs.

15. Study of frequency of stretched string with length.

16. Study of variation of frequency of stretched string with tension.

17. Study the resonance of the air column in the resonance tube and find velocity of sound.

18. Find the frequency of the given tuning fork using a resonance tube.

19. Find velocity of sound in rod by Kundt's tube.
20. Verify rectilinear propagation of light and study shadow formation.
21. Study the effect of rotation of plane mirrors on reflection.
22. Compare the refractive indices of given glass slabs.
23. Find focal length of concave mirror by locating centre of curvature.
24. Find focal length of concave mirror by object and image method.
25. Find focal length of concave mirror with converging lens.
26. Find refractive index of glass by apparent depth.
27. Find refractive index of glass by spectrometer.
28. Find focal length of converging lens by plan mirror.
29. Find focal length of converging lens by displacement method.
30. Find focal length of diverging lenses using converging lens.
31. Find focal length of diverging lens using concave mirror.
32. Find angular magnification of an astronomical telescope.
33. Find angular magnification of a simple microscope (magnifying glass).
34. Find angular magnification of a compound microscope.
35. Study working and structure of cameras.
36. Study working and structure of sextant.
37. Compare the different scales of temperature and verify the conversion formula.
38. Determine the specific heat of lead shots.
39. Find the coefficient of linear expansion of a metallic rod.
40. Find the heat of fusion of ice.
41. Find the heat of vaporization.
42. Determine relative humidity using a hygrometer.

| | | T | P | C |
|---|---|---|---|---|
| COURSE CODE: | **CIT-113** | | | |
| COURSE TITLE: | **Introduction to Computer Programming** | **2** | **3** | **3** |

A general introduction to computing and first programming language course. It aims to introduce the students to computers and IT in general and provide the knowledge and skills to use high level programming language to solve problems. It covers general introduction to computers and IT and study of the celebrated C programming language. This has a laboratory component to complement classroom discussion.

## Course Objectives (TOTAL HOURS: 64)

**At the end of the course the students are expected to be able to:**

- Understand the basic terminology and concepts of computer and Information Technology.
- Formulate logically problems and their solutions
- Use C programming language to solve problems
- Represent real-world information into computer data.
- Translate real-world problems into computer statements and solve them procedurally.
- Use input devices with ease and confidence
- Appreciate the clarity and conciseness of programming language and display patience in solving algorithmic problems

## LEARNING OBJECTIVES

**1. Introduction with the Computers and Programming Languages**

1.1. Discuss computer development
1.2. Describe computer generations
1.3. Describe electronic data processing
1.4. Explain the terms: hardware , software, and peopleware
1.5. Explain advantages of EDP
1.6. Discuss programming languages
1.7. Explain categories of programming languages
1.8. Describe machine language
1.9. Describe symbolic or assembly language
1.10. Describe high-level languages
1.11. Explain features of programming languages

## 2. Programming Cycle

2.1. Describe the programming cycle
2.2. Explain importance of readability and documentation
2.3. Describe Flowcharts
2.4. Cite advantages and disadvantages of flowcharting
2.5. Draw flowchart of procedures

## 3. The C Integrated Development Environment (IDE)

3.1. Demonstrate setting up the IDE
3.2. Explain files used in c program developer
3.3. Explain the use of IDE
3.4. Explain the structure of c programs

## 4. C Building Blocks

4.1. Define variable
4.2. Explain Input/Output
4.3. Enumerate operator symbols in C
4.4. Explain the use these operators

## 5. Conditional Control Construct: Decisions

5.1. Demonstrate use of the if Statement
5.2. Demonstrate use of the if-else Statement
5.3. Demonstrate use of the else-if Statement
5.4. Demonstrate use of the switch Statement
5.5. Write C functions using conditional statements

## 6. Iterative Control Construct: Loops

6.1. Demonstrate use of the for Loop
6.2. Demonstrate use of the while Loop
6.3. Demonstrate use of the do while Loop
6.4. Write C functions using iteration

## 7. Functions

7.1. Explain Functions
7.2. Explain Simple Functions
7.3. Explain Value-Returning Functions
7.4. Perform Parameter Passing
7.5. Demonstrate use of Multiple Functions
7.6. Describe External Variable
7.7. Explain Preprocessor Directives

## 8. Arrays and Strings

8.1. Describe Array Data Types
8.2. Demonstrate use of Single and Two-dimensional Arrays
8.3. Explain Strings

## 9. Pointers

9.1. Explain Pointers
9.2. Describe how to Return Data from Functions
9.3. Explain Pointers and Arrays
9.4. Explain Pointers and Strings
9.5. Demonstrate use of Double Indirection: Pointers to Pointers

## 10. Structures and Unions

10.1. Demonstrate use of Structures
10.2. Demonstrate use of Unions
10.3. Demonstrate use of Unions of Structures

## 11. Files

11.1. Explain Types of Disk I/O
11.2. Explain Standard Input/Output
11.3. Explain Binary and Text Mode Files
11.4. Program Record Input/Output
11.5. Explain Random Access Files
11.6. Explain Error Handling in File I/O
11.7. Explain Redirection

**12. Larger Programs**

12.1. Make Stand-alone Executables
12.2. Perform Separate Compilation
12.3. Perform Conditional Compilations
12.4. Explain Memory Models

## COURSE OUTLINE

| Contents | Hours |
|---|---|
| **1. Introduction to Computers** | **2** |
| 1.1 The History of Computers<br>1.2. Computer Generations<br>1.3. Hardware, Software, and Peopleware<br>1.4. Programming Languages<br>1.5. Categories of Programming Languages<br>1.6. Machine Languages<br>1.7. Symbolic or Assembly Language<br>1.8. High-Level Languages<br>1.9. Features of Programming Languages | |
| **2. The Programming Cycle** | **2** |
| 2.1. Defining the Problem<br>2.2. Planning and Coding Solution<br>2.3. Checking and Debugging<br>2.4. Importance of Readability and Documentation<br>2.5. Flowcharting<br>2.6. Flowchart Symbols<br>2.7. Advantages and Disadvantages of Flowcharts | |
| **3. The C Integrated Development Environment (IDE)** | **2** |
| 3.1. IDE Setup and Use of IDE<br>3.2. Files used in C Program Developer<br>3.3. The Structure of C Programs | |

**4. C Building Blocks 2**

4.1. Variable
4.2. Input/Output
4.3. Operators

**5. Conditional Control Construct: Decisions** **6**

5.1. The if Statement
5.2. The if-else Statement
5.3. The else-if Statement
5.4. The switch Statement
5.5. The Conditional Operator

**6. Iterative Control Construct: Loops** **6**

6.1. The for Loop
6.2. The while Loop
6.3. The do while Loop

**7. Functions** **8**

7.1. Introduction
7.2. Simple Functions and Value-Returning Functions
7.3. Parameter Passing
7.4. Using Multiple Functions and External Variable
7.5. Preprocessor Directives
7.6. Recursion

**8. Arrays and Strings** **6**

8.1. Introduction
8.2. Single and Two-dimensional Arrays
8.3. Strings

**9. Pointers** **10**

9.1. Introduction to Pointer
9.2. Returning Data from Functions
9.3. Pointers and Arrays
9.4. Pointers and Strings
9.5. Double Indirection: Pointers to Pointers

**10. Structures and Unions** **8**

10.1. Structures
10.2. Unions
10.3. Unions of Structures

**11. Files** **8**

11.1. Types of Disk I/O and Standard Input/Output
11.2. Binary and Text Mode
11.3. Record Input/Output and Random Access
11.4. Error conditions and Redirection

**12. Larger Programs** **8**

12.1. Making Stand-alone Executable
12.2. Separate Compilation and Conditional Compilations 12.3.Memory Models

## References


- Turbo C Programming for the PC and Turbo C++, Rev. Ed., Rober Lafore, The Waite's Group, Inc.
- C++ How to Program, 2Ed., Deitel and Deitel, Prentice-Hall
- Guide to C Programming, Jack Purdum, Ziff-Davis Press
- Mastering Turbo C, Stan Kelly-Bootle, Sybex Computer Books Inc.

# LIST OF PRACTICALS

1. Installation and Setup of C Compiler
2. Navigation of Integrated Development Environment
3. Use of Program Editor
4. Cycle of Writing C Program
5. Program: Input/Output
6. Program: Mathematical Operations
7. Program: Mathematical Operations with Conditional Statements
8. Program: Mathematical Operations with Iterations
9. Program: Functions
10. Program: Passing Parameters to Functions
11. Program: Recursion
12. Program: Emulation of String Functions
13. Program: One Dimensional Array
14. Program: Two Dimensional Array
15. Program: Structure and Records
16. Program: Pointers and Link List
17. Program: File Handling
18. Programming Project

| | | T | P | C |
|---|---|---|---|---|
| COURSE CODE: | **AI-101** | | | |
| COURSE TITLE: | **Python for Data Analytics & Wrangling** | **1** | **3** | **2** |

Teach Python programming fundamentals and Pandas/NumPy libraries to manipulate, clean, and analyze structured datasets, preparing learners for data science and analytics roles.

## COURSE OBJECTIVE:

At the end of the course the students are expected to be able to:

- Master Python syntax and fundamental data types.
- Utilize NumPy arrays for efficient numerical and mathematical operations.
- Load, inspect, and perform I/O operations on data using Pandas Data Frames and Series.
- Clean messy data by efficiently handling missing values, duplicates, and outliers.
- Transform data using techniques like merging, reshaping, and aggregation (group by, pivot table).
- Create informative and customized data visualizations using Matplotlib and Seaborn for storytelling.
- Apply advanced wrangling techniques for regex, datetime, and text processing.
- Implement end-to-end data pipelines on real-world datasets.

## COURSE DURATION:

| | | |
|---|---|---|
| Theory | 32 hours | one hour per week |
| Practical / Lab | 96 hours | one hour per week |

## DATASETS FOR PRACTICE

1. Titanic Dataset (Classification)
2. Airbnb Listings (Geospatial + Pricing)
3. COVID-19 Data (Time-series)
4. Sales Transactions (Merging/Grouping)

## TOOLS & LIBRARIES

1. Primary: Python 3.x, Pandas, NumPy, Matplotlib, Seaborn.
2. IDE: Jupyter Notebook, VS Code.
3. Optional: Dask (for big data), MissingNo (missing data visualization).

**ASSESSMENT METHODS**

1. Quizzes: MCQs on Pandas syntax (e.g., "How to drop NA values?").
2. Coding Assignments: Submit cleaned/analyzed datasets.
3. Project Submission: GitHub repo with Jupyter notebooks and a README.

**REFERENCE BOOKS:**

1. "Python for Data Analysis" by Wes McKinney (Pandas creator)
2. “Python Data Science Handbook” by Jake VanderPlas

## COURSE OUTLINE

| Contents | Hours |
|---|---|
| 1. Python Basics | 4+12 |
| 1.1 Syntax | |
| 1.2 Data Types | |
| 1.3 Loops | |
| 1.4 Functions | |
| *Tools: Python (no external libraries)* | |
| 2. NumPy Fundamentals | 4+12 |
| 2.1 Arrays | |
| 2.2 Broadcasting | |
| 2.3 Array Operations | |
| *Tools: NumPy* | |
| 3. Pandas Essentials | 4+12 |
| 3.1 DataFrames | |
| 3.2 Series | |
| 3.3 Input/Output Operations | |
| *Tools: Pandas* | |
| 4. Data Cleaning | 4+12 |
| 4.1 Handling Missing Data | |
| 4.2 Dealing with Duplicates | |
| 4.3 Outlier Detection | |
| *Tools: Pandas, NumPy* | |
| 5. Data Transformation | 4+12 |
| 5.1 Merging & Joining | |
| 5.2 Reshaping Data | |
| 5.3 Aggregations (GroupBy, Pivot Tables) | |
| *Tools: Pandas* | |

| | |
|---|---|
| 6. Data Visualization | 4+12 |
| 6.1 Basic Plots | |
| 6.2 Customization | |
| 6.3 Visual Storytelling | |
| *Tools: Matplotlib, Seaborn* | |
| 7. Advanced Wrangling | 4+12 |
| 7.1 Regex | |
| 7.2 Datetime Handling | |
| 7.3 Text Processing | |
| *Tools: Pandas, re, datetime* | |
| 8. Real-World Projects | 4+12 |
| 8.1 End-to-End Data Pipelines | |
| 8.2 Cleaning + Transformation + Visualization | |
| 8.3 Insights & Reporting | |
| *Tools: All libraries + Jupyter Notebooks* | |

# List of Practical Exercises

Exercise 1:

1.1 Create a NumPy array from a list and perform operations (mean, max, reshape).

1.2 *Dataset:* Randomly generated numbers.

Exercise 2:

2.1 Simulate dice rolls using np.random and calculate probabilities.

Exercise 3:

3.1 Load a CSV (e.g., Titanic dataset).

3.2 Explore data: .head(), .info(), .describe().

Exercise 4:

4.1 Filter rows (e.g., passengers > 30 years old) and sort by a column.

Exercise 5:

5.1 Handle missing data: drop or impute (mean/median) using .fillna().

Exercise 6:

6.1 Remove duplicates and outliers using IQR/z-score.

Exercise 7:

7.1 Merge two datasets (e.g., orders + customers) using pd.merge().

Exercise 8:

8.1 Group sales data by region and calculate summary stats (.groupby()).

Exercise 9:

9.1 Plot a histogram of ages (Matplotlib) and a boxplot of fares (Seaborn).

Exercise 10:

10.1 Create a correlation heatmap for numerical features.

Exercise 11:

11.1 Extract dates from messy strings (e.g., “Jan-2023”) using pd.to_datetime().

Exercise 12:

12.1 Clean text data: remove punctuation, lowercase, tokenize (Regex + Pandas).

Project 1: Analyze Airbnb data: clean, visualize price distribution, and map top neighborhoods.

Project 2: Wrangle COVID-19 time-series data: resample by month, calculate growth rates.

| | | T | P | C |
|---|---|---|---|---|
| COURSE CODE: | **AI-102** | | | |
| COURSE TITLE: | **SQL for Data Analytics** | **1** | **3** | **2** |

Develop proficiency in SQL to query relational databases, perform aggregations, and optimize queries for business intelligence and data extraction tasks.

## COURSE OBJECTIVE:

At the end of the course the students are expected to be able to:

- Formulate efficient SELECT queries using filtering, sorting, and limiting clauses.
- Join multiple tables (INNER, LEFT, RIGHT) to combine disparate data for comprehensive analysis.
- Perform aggregations using GROUP BY and HAVING to summarize data (e.g., calculate monthly revenue).
- Utilize Subqueries and Common Table Expressions (CTEs) for complex, multi-step data retrieval.
- Apply Window Functions (ROW_NUMBER(), RANK(), PARTITION BY) for advanced analytical tasks like ranking within groups.
- Diagnose and optimize slow queries by analyzing execution plans and implementing indexes.
- Design and execute end-to-end analytical pipelines using relational databases.

## COURSE DURATION:

| | | |
|---|---|---|
| Theory | 32 hours | one hour per week |
| Practical / Lab | 96 hours | one hour per week |

## DATASETS FOR PRACTICE

1. Northwind Database (Classic relational dataset for joins/aggregations).
2. IMDb Dataset (Movies/ratings for complex queries).
3. COVID-19 SQL Database (Time-series analysis).

## TOOLS & PLATFORMS

- RDBMS: PostgreSQL (recommended), MySQL, SQLite.
- IDEs: DBeaver, pgAdmin, VS Code + SQL extensions.
- Sandbox: SQL Fiddle, DB<>Fiddle.

## ASSESSMENT METHODS

- Quizzes: MCQ on query logic (e.g., "What does LEFT JOIN return?").
- Coding Challenges: Fix broken queries or write optimized ones.
- Project Review: GitHub repo with SQL scripts and an analysis report.

## RECOMMENDED BOOKS

1. "SQL for Data Analysis" – *Cathy Tanimura* (O'Reilly)
2. *"Practical SQL: A Beginner's Guide to Storytelling with Data" by Anthony DeBarros*

## COURSE OUTLINE

| Contents | Hours |
|---|---|
| 1. SQL Fundamentals | 4+12 |
| 1.1 Syntax | |
| 1.2 SELECT statements | |
| 1.3 Filtering (WHERE) | |
| 1.4 Sorting (ORDER BY) | |
| 1.5 Limiting results (LIMIT) | |
| *Tools/Concepts: WHERE, ORDER BY, LIMIT* | |
| 2. Joins & Relationships | 4+12 |
| 2.1 INNER JOIN | |
| 2.2 LEFT JOIN | |
| 2.3 RIGHT JOIN | |
| 2.4 FULL JOIN | |
| 2.5 Aliases | |
| 2.6 Multi-table queries | |
| *Tools/Concepts: Joins, aliases, multi-table queries* | |
| 3. Aggregations | 4+12 |
| 3.1 GROUP BY | |
| 3.2 HAVING | |
| 3.3 SUM() | |
| 3.4 COUNT() | |
| 3.5 AVG() | |
| *Tools/Concepts: SUM(), COUNT(), AVG()* | |

| | |
|---|---|
| 4. Subqueries & CTEs | 4+12 |
| 4.1 Nested Queries | |
| 4.2 Common Table Expressions (CTEs) | |
| 4.3 WITH Clauses | |
| *Tools/Concepts: Subqueries, WITH clauses* | |
| 5. Window Functions | 6+16 |
| 5.1 ROW_NUMBER() | |
| 5.2 RANK() | |
| 5.3 PARTITION BY | |
| *Tools/Concepts: Analytical functions* | |
| 6. Optimization | 6+16 |
| 6.1 Indexes | |
| 6.2 Query Performance | |
| 6.3 EXPLAIN / Execution Plans | |
| 6.4 Indexing Strategies | |
| *Tools/Concepts: Execution plans, indexing strategies* | |
| 7. Real-World Projects | 4+12 |
| 7.1 End-to-end analytics pipelines | |
| 7.2 Cleaning & transforming datasets | |
| 7.3 Reporting and insights | |
| *Tools/Concepts: All concepts combined* | |

# List of Practical Exercises

Exercise 1:

1.1 Query a customers table: Filter by registration date and sort by name.

```
SELECT * FROM customers
WHERE registration_date > '2023-01-01'
ORDER BY last_name;
```

Exercise 2:

2.1 Combine orders and customers tables to find orders from VIP customers.

```
SELECT o.order_id, c.customer_name
FROM orders o
INNER JOIN customers c ON o.customer_id = c.id
WHERE c.is_vip = TRUE;
```

Exercise 3:

3.1 Calculate monthly revenue from an orders table.

```
SELECT
  EXTRACT(MONTH FROM order_date) AS month,
  SUM(amount) AS revenue
FROM orders
GROUP BY month
HAVING SUM(amount) > 10000;
```

Exercise 4:

4.1 Find products with above-average prices using a subquery.

```
SELECT product_name, price
FROM products
WHERE price > (SELECT AVG(price) FROM products);
```

Exercise 5:

5.1 Rank employees by salary within departments.

```
SELECT
  employee_name,
  department,
  salary,
  RANK() OVER (PARTITION BY department ORDER BY salary DESC) AS
dept_rank
FROM employees;
```

Exercise 6:

6.1 Use EXPLAIN to analyze a slow query and optimize it with an index.

```
CREATE INDEX idx_customer_id ON orders(customer_id);
```

Project 1: Analyze e-commerce data: Calculate customer lifetime value (CLV) and identify churn risks.

Project 2: Build a financial report: Compare quarterly sales growth with window functions.

| | | T | P | C |
|---|---|---|---|---|
| COURSE CODE: | **AI-103** | | | |
| COURSE TITLE: | **Exploratory Data Analysis (EDA)** | **1** | **3** | **2** |

Train learners to systematically investigate datasets using statistical and visual techniques to uncover patterns, anomalies, and actionable insights.

## COURSE OBJECTIVE:

At the end of the course the students are expected to be able to:

- Understand the goals and workflows of a systematic EDA process.
- Calculate and interpret descriptive statistics including central tendency, dispersion, and skewness.
- Design and create appropriate data visualizations (histograms, boxplots, trend plots) to analyze distributions, trends, and outliers.
- Identify and analyze feature relationships through correlations and other statistical measures.
- Effectively manage missing data (imputation/dropping) and detect outliers using visualization and statistical methods.
- Perform Advanced EDA techniques for specific data types such as time-series and text data.
- Utilize automated EDA libraries to quickly generate high-level dataset reports.
- Present analytical findings clearly as a cohesive "data story".

## COURSE DURATION:

| | | |
|---|---|---|
| Theory | 32 hours | one hour per week |
| Practical / Lab | 96 hours | one hour per week |

## DATASETS FOR PRACTICE

1. Titanic (Structured, mixed data types)
2. Airbnb Listings (Geospatial, pricing)
3. COVID-19 (Time-series)
4. IMDB Reviews (Text data)

## TOOLS & LIBRARIES

- Core: Python (Pandas, NumPy), Jupyter Notebooks
- Visualization: Matplotlib, Seaborn, Plotly
- Automation: Pandas-profiling, Sweetviz
- SQL Integration: PostgreSQL + Python (sqlalchemy)

## ASSESSMENT METHODS

- Quizzes: MCQ on EDA concepts (e.g., "When to use log transform?")
- Code Submissions: Jupyter notebooks with annotated insights.
- Presentation: 5-min "data story" on findings (e.g., "Why do luxury Airbnb listings cluster in Area X?").

## RECOMMENDED BOOKS

1. "Python for Data Analysis" by *Wes McKinney* (Pandas-focused EDA)
2. “Deep Learning with Python” by François Chollet

## COURSE OUTLINE

| Contents | Hours |
|---|---|
| 1. EDA Foundations | 4+12 |
| 1.1 Goals of EDA | |
| 1.2 Workflows & Methodology | |
| 1.3 Data Types (Numerical, Categorical, Date/Time) | |
| *Tools: Pandas, NumPy* | |
| 2. Descriptive Statistics | 4+12 |
| 2.1 Measures of Central Tendency (Mean, Median, Mode) | |
| 2.2 Measures of Dispersion (Variance, Std, Range) | |
| 2.3 Skewness & Kurtosis | |
| *Tools: Pandas, SciPy* | |
| 3. Data Visualization | 4+12 |
| 3.1 Histograms | |
| 3.2 Boxplots | |
| 3.3 Scatterplots & Trends | |
| 3.4 Outlier Detection via Visualization | |
| *Tools: Matplotlib, Seaborn, Plotly* | |

4. Feature Analysis 4+12
    4.1 Correlation Analysis
    4.2 Feature Importance
    4.3 Heatmaps for Feature Relationships
    *Tools: Pandas, Scikit-learn*

5. Missing Data & Outliers 4+12
    5.1 Missing Data Detection
    5.2 Imputation Techniques
    5.3 Outlier Detection (IQR, Z-score)
    *Tools: Pandas, Missingno*

6. Advanced EDA 4+12
    6.1 Time-Series Analysis (Resampling, Trends)
    6.2 Geospatial Data Exploration
    6.3 Text EDA (Frequency, Word Clouds)
    *Tools: Statsmodels, GeoPandas, NLTK*

7. Automated EDA 4+12
    7.1 Pandas-Profiling
    7.2 Sweetviz
    7.3 Quick Insights & Reports
    *Tools: Pandas-Profiling, Sweetviz*

8. Case Studies 4+12
    8.1 End-to-End EDA Projects
    8.2 Cleaning, Transformation, and Visualization
    8.3 Presentation of Insights
    *Tools: All libraries + Jupyter Notebooks*

# List of Practical Exercises

Exercise 1:

- Load a dataset (e.g., Titanic).
- Use .info(), .describe(), and .value_counts() to summarize data.
- Deliverable: A markdown table with key observations.

Exercise 2:

- Analyze numerical features: Calculate skewness, kurtosis, and IQR.
- Code:

```
print(df['age'].skew())
print(df['fare'].kurtosis())
```

Exercise 3:

- Plot a histogram (distribution) and boxplot (outliers) for a numerical column.
- Code:

```
sns.histplot(df['age'], kde=True)
sns.boxplot(df['fare'])
```

Exercise 4:

- Create a correlation heatmap and identify top 3 correlated features.
- Code:

```
sns.heatmap(df.corr(), annot=True)
```

Exercise 5:

- Visualize missing data with missingno.matrix(df).
- Impute missing ages using median or predictive modeling.

Exercise 6 (Time-Series):

- Resample COVID-19 data to weekly cases and plot trends.

```
Df.resample('W').sum()['cases'].plot()
```

Exercise 7 (Text EDA):

- Analyze word frequency in Twitter data using nltk.FreqDist().

Exercise 8:

- Generate a Pandas-profiling report for a dataset.

```
From pandas_profiling import ProfileReport
ProfileReport(df).to_file('report.html')
```

Project 1: Analyze Airbnb data: Price distribution by neighborhood, seasonality trends.

Project 2: Investigate healthcare data: Patient readmission rates vs. features.

| | | T | P | C |
|---|---|---|---|---|
| COURSE CODE: | **AI-104** | | | |
| COURSE TITLE: | **Data Handling & Visualization** | **1** | **3** | **2** |

To master the process of acquiring, cleaning, and transforming raw data into a structured format, and to effectively communicate insights through powerful visualizations using libraries like Pandas, NumPy, and Matplotlib/Seaborn.

## COURSE OBJECTIVE:

At the end of the course the students are expected to be able to:

- Master data fundamentals including Python data structures and file I/O operations (CSV/JSON).
- Acquire data from various sources, including APIs, web scraping, and databases (SQLite).
- Clean and transform data effectively, addressing missing data, outliers, and applying necessary transformations.
- Conduct Exploratory Analysis using descriptive statistics and correlation to uncover data insights.
- Create basic and advanced plots using Matplotlib and Seaborn, understanding the figure and axes components.
- Build interactive and geospatial visualizations using modern libraries like Plotly and Folium.
- Develop simple, shareable dashboards using Python frameworks like Streamlit and Panel.
- Execute end-to-end data projects, implementing the full data pipeline from acquisition to visualization.

## COURSE DURATION:

| | | |
|---|---|---|
| Theory | 32 hours | one hour per week |
| Practical / Lab | 96 hours | one hour per week |

## DATASETS:

- COVID-19 Data (Time-series)
- Amazon Reviews (Text)
- World Happiness Report (EDA)

**ASSESSMENT METHODS:**

- Bi-weekly: Visualization critiques (Design + Insight)
- Project: EDA report (Jupyter Notebook + PDF summary)
- Quiz: SQL/Pandas syntax challenges

**TOOLS:**

- Pandas/Matplotlib (Python)
- Tableau Public (Dashboards)
- Kaggle Notebooks (Cloud IDE)

**REFERENCE BOOK:**

- "Python for Data Analysis" by Wes McKinney (pandas creator)

## COURSE OUTLINE

| Contents | Hours |
|---|---|
| 1. Data Fundamentals | 4+12 |
| ● Data types, structures, file I/O<br>○ Key Tools/Concepts: Python (pandas), CSV/JSON | |
| 2. Data Acquisition | 4+12 |
| ● APIs, web scraping, databases<br>○ Key Tools/Concepts: requests, BeautifulSoup, SQLite | |
| 3. Data Cleaning | 4+12 |
| ● Missing data, outliers, transformations<br>○ Key Tools/Concepts: pandas, numpy, regex | |

4. Exploratory Analysis 4+12

- Descriptive stats, correlation
    - Key Tools/Concepts: pandas, scipy.stats

5. Visualization Basics 4+12

- Matplotlib, Seaborn fundamentals (Figure, Axes)
    - Key Tools/Concepts: Figure, Axes, plot types

6. Advanced Viz 4+12

- Interactive plots, geospatial
    - Key Tools/Concepts: Plotly, Folium

7. Dashboarding 4+12

- Streamlit, Panel
    - Key Tools/Concepts: Layouts, widgets

8. Capstone Projects 4+12

- End-to-end data projects
    - Key Tools/Concepts: Full pipeline implementation

## List of Practical Exercises

1. Create a data frame from scratch with student records
2. Convert JSON weather data to CSV format
3. Scrape Wikipedia population tables
4. Fetch real-time crypto prices via API
5. Handle missing values in Titanic dataset
6. Normalize inconsistent address formats
7. Analyze movie ratings distribution
8. Find correlation between GDP and life expectancy
9. Plot COVID-19 case trends with Matplotlib
10. Create a boxplot of income by education level
11. Make an interactive Plotly bubble chart
12. Visualize earthquake data on Folium map
13. Build a Stream lit app for stock analysis
14. Create a Panel dashboard with climate data
    - Option A: News sentiment analyzer with visualizations
    - Option B: Personal finance tracker with dashboards

# SYLLABI

# DAE IN ARTIFICIAL INTELLIGENCE

# SECOND YEAR

| | | T | P | C |
|---|---|---|---|---|
| COURSE CODE: | **GEN-211** | | | |
| COURSE TITLE: | **Islamiat / Pak Studies** | **1** | **0** | **1** |

یہ کورس طلباء کو اسلامیات اور مطالعہ پاکستان کے بنیادی اصولوں اور تصورات سے روشناس کراتا ہے۔ اس کا مقصد طلباء میں دینی اور قومی شعور کو اجاگر کرنا اور انہیں ملک کے نظریاتی اور تاریخی پس منظر سے واقف کرانا ہے۔

## COURSE OBJECTIVE: کورس کے متوقع مقاصد

### 1. قرآن مجید (The Holy Quran)

**عمومی مقصد :** مطالبہ کا یہ جان سکے کہ لایاتِ قرآنی کی روشنی میں مومن کے اوصاف کیا ہیں

**خصوصی مقاصد:**

- قرآنی آیات کا ترجمہ بیان کر سکے
- قرآنی آیات کی تشریح کر سکے
- قرآنی آیات کی روشنی میں ایک مومن کے اوصاف بیان کر سکے
- قرآنی آیات میں بیان کردہ مومن کے اوصاف اپنے اندر پیدا کر سکے

### 2. احادیث نبویہ (Prophetic Sayings/Hadith)

**عمومی مقصد:** احادیث کی روشنی میں اسلامی اخلاقی اقدار (انفرادی و اجتماعی) سے آراستہ ہو سکے

**خصوصی مقاصد:**

- احادیث کا ترجمہ بیان کر سکے
- احادیث کی تشریح کر سکے
- احادیث کی روشنی میں اسلام کی اخلاقی اقدار کی وضاحت کر سکے
- ان احادیث کی دی گئی تعلیمات کے مطابق اپنی زندگی گزار سکے

### 3. سیرت طیبہ (Holy Life of the Prophet PBUH)

**عمومی مقصد :** حضور اکرم ﷺ کی سیرت طیبہ کے بارے میں جان سکے

**خصوصی مقاصد:**

- حضور اکرم ﷺ کی ابتدائی زندگی اختصار کے ساتھ بیان کر سکے
- حضور اکرم ﷺ کی ہجرت کا واقعہ بیان کر سکے
- حضور اکرم ﷺ کی عملی زندگی اختصار سے بیان کر سکے
- حضور اکرم ﷺ کی بطورِ معلم خصوصیات بیان کر سکے
- حضور اکرم ﷺ کی بطورِ سر براہ خاندان بیان کر سکے

### 4. اسلامی معاشرہ (Islamic Society)

**عمومی مقصد:** اسلامی معاشرہ کی خصوصیات سے آگاہی حاصل کر سکے

**خصوصی مقاصد:**

- اسلامی معاشرہ کا معنی و مفہوم بیان کر سکے
- اسلامی معاشرہ کی امتیازی خصوصیات بیان کر سکے
- اسلامی معاشرہ میں عدل و احسان کی اہمیت بیان کر سکے

### 5. تبلیغ کے نقوش

**خصوصی مقاصد (Specific Objectives):**

- تبلیغ کی اہمیت و ضرورت بیان کر سکے
- جہد کے لغوی و اصطلاحی معنی بیان کر سکے
- جہاد کی اہمیت بیان کر سکے
- جہاد اور قتال میں فرق بیان کر سکے
- جہاد کی مختلف اقسام بیان کر سکے
- لفظ مسجد کی تعریف کر سکے

# مطالعہ پاکستان (Pakistan Studies)

## حصہ دوم (Part Two)

**عمومی مقصد: تحریک پاکستان:** قیام پاکستان کے اسباب و محرکات کو بیان کر سکے

**خصوصی مقاصد :**

- قومیت کے مفہوم کو بیان کر سکے
- دو قومی نظریہ کی تعریف و توضیح کر سکے
- دو قومی نظریہ کی اہمیت بیان کر سکے
- ہندوستان مسلمانوں کی محرومیوں کو بیان کر سکے
- قومی تشخص کو بحال رکھنے کے لیے مسلمانانِ ہند کی مساعی بیان کر سکے
- آزادی ہند اور قیام پاکستان، علامہ اقبال اور قائد اعظم کی مساعی بیان کر سکے
- قیام پاکستان سے مستقبل اسلامی مملکت کے قیام کے لیے مسلم عوام کی کوششوں کو بیان کر سکے
- مسلم لیگ کے قیام پاکستان کے لیے جدوجہد بیان کر سکے

# اسلامیات

**حصہ دوم** **(Part Two)**

موضوعات (Topics):

1. سورة المومنون آیت ایک تیرہ آیات کا مع ترجمہ 2.
منتخب سورتوں مع ترجمہ و تشریح
   a. خياركم من تعلم القرآن و علمه
   b. الإيمان لمن لا أمانة له ولا دين لمن لا عهد له
   c. و إياكم والظن، فإن الظن أكذب الحديث
   d. من أحدث في أمرنا هذا ما ليس منه، فهو رد
   e. من حمل علينا السلاح فليس منا
   f. لو كان لابن آدم واديان من ذهب لابتغى لهما ثالثاً g. لا ضرر ولا ضرار في الإسلام
   h. كلكم راع وكلكم مسؤول عن رعيته
3. سیرتِ طیبہ:
   a. مکی زندگی, ولادت, بعثت, ہجرت
4. مدنی زندگی، مواخات، میثاق مدینہ , فتح مکہ (اسباب و نتائج) 5.
حضور ﷺ بحیثیت:
   a. معلم کامل، سربراہ خاندان
6. اسلامی معاشرہ
   a. نظامِ تعلیم اور اس کے مقاصد، عدل و انصاف، امر بالمعروف و نہی عن المنکر
7. اسلامی ریاست کی تعریف، اسلامی ریاست کی خصوصیات، اسلامی حکومت کے فرائض، اسلامی طرز حکوم

# نصاب مطالعہ پاکستان (Pakistan Studies Curriculum)

**سال دوم** **(Second Year)**

**موضوعات:**

1. دو قومی نظریہ (Two-Nation Theory)
2. تحریک پاکستان (Pakistan Movement)
3. انڈین کانگریس (Indian Congress)
4. مسلم لیگ (Muslim League)
5. تقسیم بنگال 6. (Partition of Bengal)
مسئلہ کشمیر (Kashmir Issue)
7. تحریک خلافت (Khilafat Movement)
8. سندھ تحریک (Sindh Movement)
9. تجدید و احیا (Renewal and Revival)
10. سعودیہ رپورٹ (Saudi Report)
11. قائد اعظم کے چیدہ نکات (Key Points of Quaid-e-Azam's Speeches)
12. خطبہ الہ آباد (Khutba e Allabad)
13. اقلیت 1938 اور داخلی اتحاد (Minority 1938 and Internal Unity)
14. قراردادِ پاکستان (Pakistan Resolution)

| | | T | P | C |
|---|---|---|---|---|
| COURSE CODE: | **GEN-211** | | | |
| COURSE TITLE: | **Islamiat / Pak Studies(Non-Muslims)** | **1** | **0** | **1** |

## نصاب اخلاقیات (سال دوم)

تدریسی مقاصد:

عمومی مقصد: طالب علم اخلاقیات کی اہمیت و ضرورت سے سمجھ بوجھ کر بیان کر سکے۔
خصوصی مقاصد: طالب علم اس قابل ہو کہ:

- موضوعات کا مطلب بیان کر سکے۔
- عملی زندگی سے مثالوں کی نشاندہی کر سکے۔
- اپنی شخصیت اور معاشرے پر موضوعات کے متعلق مثبت اثرات پیدا کرنے کے طریقے بیان کر سکے۔
- اعلٰی اخلاقی اقدار:
  - قوتِ برداشت، قوتِ ارادی، لگن و جذبہ، وسیع النظری، بے غرضی، انسانی دوستی، حفاظتی شعور، پاسِ آزادی، کامل آگہی اور خودشناسی کی اہمیت بیان کر سکے۔
- اخلاقیات سے متصف ہو کر قومی خدمت بہتر طور پر انجام دے سکے۔

**موضوعات:**

1. حقوق و فرائض 2. قوتِ برداشت 3. قوتِ ارادی
4. لگن و جذبہ 5. وسیع النظری 6. بے غرضی 7. انسانی دوستی 8. حفاظتی شعور 9. پاسِ آزادی
10. کامل آگہی
11. تبدیلات کو قبول کرنا 12. خودشناسی

Course Code: **MGM -211**
Course Title: **Business Communication**

| T | P | C |
|---|---|---|
| 1 | 3 | 2 |

Second course on English language focusing on business communication. It aims to develop communication skills as applied in business and commerce such as the writing and business correspondence. It covers oral communication and art of listening, interviewing, and report writing among others. It is a pure class discussion.

**Course Objectives:**

At the end of the course the students are expected to be able to

- Understand the basic principles of good and effective business writing in commercial and industrial fields.
- Use the English language effectively for communication in business
- Apply knowledge and skill to write business communication with confidence and ease.
- Write legibly in handwriting and compose communication documents with correct formats.
- Appreciate the usefulness of written language

## LEARNING OBJECTIVES

**1. Communication Process**

1.1. Understand the communication process
1.2. State the benefits of two way communication
1.3. Describe a model of communication process.
1.4. Explain the major communication methods used in organization
1.5. Identify the barriers to communication and methods of overcoming these barriers
1.6. Identify misconceptions about communication

**2. Oral Communication Skills**

2.1. Understand the process of oral communication
2.2. Identify speaking situations with other people.
2.3. Identify the strategy steps of speaking.
2.4. Identify the characteristics of effective speaking.
2.5. State the principles of one-way communication.
2.6. State the principles of two-way communication.
2.7. Identify the elements of oral presentation skills.
2.8. Determine the impact of non-verbal communication on oral communication.

**3. Questioning Skills**

3.1. Determine the uses of questioning skills and clarify information in the oral communication process
3.2. Identify different types of questions.
3.3. Determine the purpose of each type of question and its application.
3.4. Identify the hazards to be avoided when asking questions.
3.5. Demonstrate questioning skills.

**4. Listening Skills**

4.1. Demonstrate the use of active listening skill in the oral communication process
4.2. State the principles of active listening.
4.3. Identify skills of active listening.
4.4. Identify barriers to active listening.
4.5. State the benefits of active listening.
4.6. Demonstrate listening skills.
4.7. Explain the importance of giving and receiving feedback.

**5. Interview Skills**

5.1. Determine the appropriate interview type for the specific work-related situation and conduct a work-related interview.
5.2. State the significance of interviews.
5.3. State the characteristics of interviews.
5.4. Explain the activities in an interviewing situation.
5.5. Describe the types of interviews
5.6. Explain the interviewing strategy
5.7. Prepare instrument for a structured interview

**6. Report Writing**

6.1. Prepare a report out-line, based on subject matter and audience
6.2. Identify the different types of reports
6.3. Determine when to use an informal or formal report presentation
6.4. Identify the stages of planning a report
6.5. Identify the parts of a report and choose the parts appropriate for each type of report
6.6. Draft a report outline

**7. Reading Comprehension**

7.1. Demonstrate reading comprehension
7.2. Identify major reading problems
7.3. Identify basic reading skills.
7.4. State methods of previewing written material
7.5. Identify methods of concentration when reading.
7.6. Demonstrate reading comprehension.

**8. Group Communication**

8.1. Understand the principles of group communications
8.2. State the purpose and characteristics of major types of meeting.
8.3. Explain responsibilities of a meeting/committee.
8.4. Identify problems likely to be faced at a meeting and means to overcome these problems.
8.5. Distinguish between content and process at meetings.
8.6. Explain the key characteristics of a good group facilitator.

**COURSE OUTLINE( Total Hours: 32)**

| Contents | Hours |
|---|---|
| **1. Communication Process.** | **6** |
| 1.1. Purposes of communication<br>1.2. Communication process<br>1.3. Distortions in communication<br>1.4. Consolidation of communication<br>1.5. Communication flow<br>1.6. Communication for self development | |
| **2. Oral Communication Skills** | **6** |
| 2.1. Significance of Speaking<br>2.2. Verbal and Non-verbal Messages<br>2.3. Strategic Steps of Speaking<br>2.4. Characteristics of Effective Oral Messages<br>2.5. Communication Trafficking<br>2.6. Oral Presentation | |
| **3. Questioning Skills** | **3** |
| 3.1. Nature and Types of Questions<br>3.2. Characteristics of a Good Questions<br>3.3. Questioning Strategy | |
| **4. Listening Skills** | **5** |
| 4.1. Principles of Active Listening<br>4.2. Skills of Active Listening<br>4.3. Barriers to Listening<br>4.4. Reasons for Poor Listening.<br>4.5. Giving Feedback. | |
| **5. Interviewing Skills** | **3** |
| 5.1. Significance of Interviews<br>5.2. Characteristics of Interviews<br>5.3. Activities in an Interviewing Situation<br>5.4. Types of Interviews.<br>5.5. Interviewing Strategy. | |

**6. Report Writing** **3**

6.1. Goals of Report Writing
6.2. Report Format
6.3. Types of Reports
6.4. Report Writing Strategy.

**7. Reading Comprehension** **2**

7.1. Reading Problems
7.2. Four Reading Skills

**8. Group Communication** **4**

8.1. Purposes of Conducting Meetings
8.2. Planning a Meeting
8.3. Types of Meetings
8.4. Selection of a Group for Meeting
8.5. Group Leadership Skills
8.6. Running a Successful Meeting
8.7. Active Participation Techniques

## References:


- Effective Business Communication and Report Writing, Sh. Ata-ur-Rehman.
- Technical Reporting, Ulman J.N. Could JR..

| | | T | P | C |
|---|---|---|---|---|
| COURSE CODE: | **MATHS-233** | | | |
| COURSE TITLE: | **Applied Mathematics-II** | **3** | **0** | **3** |

**Total Contact Hrs:**

- Theory: 96 Hrs.
- Practical: 0

**Aims & Objectives:**

After completing the course the students will be able to:

- Solve the problems of calculus and analytical Geometry.

## Course Contents:

**1. FUNCTIONS & LIMITS.** **6 Hours**

1.1 Constants and variables
1.2 Functions & their types
1.3 The concept of limit
1.4 Limit of a function
1.5 Fundamental theorems on limit
1.6 Some important limits
1.7 Continuous function
1.8 Problems

**2. DIFFERENTIATION.** **06 Hours**

2.1 Increments
2.2 Geometrical interpret
2.3 Differentiation ab –initio by first principle.
2.4 Geometrical interpretation of differential coefficient.
2.5 Differentiation coefficient of $X^n$ and $(a+b)^n$
2.6 Problems.

**3. DIFFERENTIATION OF ALGEBRAIC FUNCTIONS** **9 Hours**

3.1 Explicit Functions
3.2 Implicit Functions
3.3 Parametric Forms
3.4 Problems

**4. DIFFERENTIATION OF TRIGONOMETRIC FUNCTIONS** **6 Hours**

4.1 Differential Coefficient of Sinx, Cosx, Tanx from first principle.
4.2 Differential Coefficient of Cosecx, Secx, Cotx.
4.3 Differential Coefficient of Inverse Trigonometric Functions
4.4 Problems

**5. DIFFERENTIATION OF LOGARITHMIC & EXPONENTIAL FUNCTION** **15 Hours**

5.1 Differentiation of lnx
5.2 Differentiation of Log $a^x$
5.3 Differentiation of $a^x$
5.4 Differentiation of $e^x$
5.5 Problems

**6. RATE OF CHANGE OF VARIABLES.** **6 Hours**

6.1 Increasing and decreasing functions
6.2 Maxima and Minima
6.3 Criteria for maximum & minimum values
6.4 Methods of finding maximum & minimum
6.5 Rate measure
6.6 Slope of a line
6.7 Velocity and acceleration
6.8 Problems

**7. INTEGRATION (SIMPLE BASIC RULES)** **9 Hours**

7.1 Concept
7.2 Fundamental Formulae
7.3 Important Rules
7.4 Problems

**8. METHODS OF INTEGRATION** **9 Hours**

8.1 Integration by substitution
8.2 Integration by parts
8.3 Problems

**9. DEFINITE INTEGRALS.** **6 Hours**

9.1 Properties
9.2 Application to area
9.3 Problems.

**10. DIFFERENTIAL EQUATION. 6 Hours**

10.1 Introduction
10.2 Order and Degree
10.3 First Order Differential Equation of 1st Degree
10.4 Solution of Problems
10.5 Problems

**11. LAPLACE TRANSFORMATION. 9 Hours**

11.1 Laplace Transformations
11.2 Inverse Laplace Transformations
11.3 Problems

**12. FOURIER SERIES 9 Hours**

12.1 Introduction
12.2 Periodic Functions
12.3 Even and Odd Functions
12.4 Problems

**13. STATISTICS 6 Hours**

13.1 Concept of mean, median and mode
13.2 Standard Deviation
13.3 Laws of probability
13.4 Problems

**RECOMMENDED BOOKS**

1. Thomas Finny, Calculus and Analytic Geometry
2. Ghulam Yasin Minhas, Technical Mathematics Vol –I & II, Ilmi Kitab Khana, Lahore
3. Riaz Ali Khan, Polytechnic Mathematic Series Vol I & II, Majeed Sons, Faisalabad.
4. Sana Ullah Bhatti, Calculus and Analytic Geometry, Punjab Text Book Board, Lahore.

| | | T | P | C |
|---|---|---|---|---|
| COURSE CODE: | **AI-201** | | | |
| COURSE TITLE: | **Computation Foundation For AI** | **1** | **3** | **2** |

To establish a strong foundation in computational thinking, core programming concepts using Python, and the essential mathematical principles (algebra, statistics) that underpin all data science and AI workflows.

## COURSE OBJECTIVE:

At the end of the course the students are expected to be able to:

- Understand the basics of computational thinking and the Python programming interface.
- Master Python syntax, data types, and logic mastery (conditionals, loops).
- Apply core mathematical concepts including algebra, coordinate geometry, and binary representation.
- Define and use functions and methods, understanding parameter passing and scope.
- Utilize fundamental data structures in Python, such as lists, tuples, and dictionaries.
- Apply mathematical principles in code, particularly in probability and statistics.
- Practice debugging and optimization techniques, including error handling and time complexity analysis.

## COURSE DURATION:

| | | |
|---|---|---|
| Theory | 32 hours | one hour per week |
| Practical / Lab | 96 hours | one hour per week |

## ASSESSMENT METHODS:

- Code submissions via GitHub/GitLab.
- Peer code reviews.
- Live debugging demonstrations.

## TOOLS AND TECHNOLOGIES:

- Programming: Python (Jupyter Notebooks).
- Math Visualization: Desmos / GeoGebra.
- Submission Tracking: GitHub Classroom.
- Datasets: Titanic Dataset, Iris Dataset, NBA player stats.

**REFERENCE BOOKS**

- "Math for Programmers" by Paul Orland.

## COURSE OUTLINE

| Contents | Hours |
|---|---|
| 1. Programming Basics | 4+12 |
| 2. Core Math Concepts | 4+12 |
| 3. Logic Mastery | 4+12 |
| 4. Functions & Methods | 4+12 |
| 5. Data Structures | 4+12 |
| 6. Applied Mathematics | 4+12 |

- Interface, syntax, data types
    - Key Tools/Concepts: Python interpreter, variables
- Algebra, coordinate geometry, binary
    - Key Tools/Concepts: Jupyter Notebooks, Desmos
- Conditionals, loops, boolean logic
    - Key Tools/Concepts: if/else, for/while loops
- Parameters, return values, scope
    - Key Tools/Concepts: def, return, local vs global
- Lists, tuples, dictionaries
    - Key Tools/Concepts: [], {}, .append(), .keys()
- Probability, statistics, basic algorithms
    - Key Tools/Concepts: random module, mean/median

7. Debugging & Optimization 4+12

- Error handling, code efficiency
    - Key Tools/Concepts: try/except, time complexity

8. Capstone Projects 4+12

- End-to-end coding solutions
    - Key Tools/Concepts: All concepts combined

# LIST OF PRACTICAL EXERCISES

1. Installation Challenge
    - Set up Python + Jupyter Notebook
    - Print "Hello [Your Name]" with user input
2. Variable Lab
    - Create a "Pet Age Calculator" (human years → dog years)
    - Swap two variables without a temporary variable
3. Math Visualizer
    - Plot a parabola using Desmos/Python ($y = x^2$)
    - Convert your birth year to binary/hexadecimal
4. Geometry Builder
    - Calculate hypotenuse length given two sides
    - Plot a star shape using coordinate points
5. Conditional Challenges
    - "Wizard School Admission" (if/elif/else for grade checks)
    - Build a BMI category classifier
6. Loop Drills
    - Print multiplication tables (1-12)
    - Guessing game with 3 attempts (while loop)
7. Function Workshop
    - Temperature converter (Celsius ↔ Fahrenheit)
    - "Math Helper" with add/subtract/multiply functions
8. Scope Experiment
    - Demonstrate local vs global variables with a counter
9. List Operations

- To-do list manager (add/remove/prioritize tasks)
- Analyze test scores (find max/min/average)

10. Dictionary Applications
    - Student gradebook (name:grade pairs)
    - Word frequency counter for a sentence
11. Probability Simulators
    - Dice roll histogram (1000 rolls)
    - Monty Hall problem simulation
12. Statistical Analysis
    - Calculate mean/median of exam scores
    - Find correlation between study hours and grades
13. Bug Hunt
    - Fix 5 intentionally broken code snippets
    - Optimize a slow Fibonacci calculator
14. Efficiency Lab
    - Compare loop vs list comprehension speeds
    - Time complexity analysis of search algorithms

**Choose One:**

15. Math Visualizer
    - Interactive Fibonacci sequence plotter
    - Prime number sieve with visualization
16. Game Development
    - Text-based adventure (rooms/items)
    - "Math Dragon" battle game (solve equations to attack)
17. Real-World Tool
    - Personal finance tracker
    - Automated quiz generator (reads questions from file)

| | | T | P | C |
|---|---|---|---|---|
| COURSE CODE: | **AI-202** | | | |
| COURSE TITLE: | **Business Intelligence Insight Platform (BIIP)** | **1** | **3** | **2** |

Enable learners to design interactive dashboards and perform advanced analytics using Power BI, from data modeling to sharing insights enterprise-wide.

## COURSE OBJECTIVE:

At the end of the course the students are expected to be able to:

- Master the Power BI Desktop interface, data loading, and basic transformations.
- Clean and shape data efficiently using the Power Query Editor.
- Design effective Data Models including building relationships and implementing the star schema.
- Write complex analytical DAX measures for calculations like time intelligence and Key Performance Indicators (KPIs).
- Create informative reports and design interactive dashboards using various visualizations, slicers, and bookmarks.
- Apply advanced analytics features, including quick measures and integrating R/Python visuals.
- Publish, manage, and share reports in the Power BI Service.
- Implement security protocols such as Row-Level Security (RLS) to govern data access.

## COURSE DURATION:

| | | |
|---|---|---|
| Theory | 32 hours | one hour per week |
| Practical / Lab | 96 hours | one hour per week |

## DATASETS FOR PRACTICE

1. AdventureWorks (Microsoft's sample database for BI).
2. Superstore Sales (Orders, returns, regional data).
3. COVID-19 Business Impact (Time-series + geospatial).

## TOOLS & RESOURCES

- Core: Power BI Desktop, Power BI Service.
- DAX Guide: dax.guide
- Custom Visuals: Marketplace (e.g., Chiclet Slicer).

## ASSESSMENT METHODS

- Quizzes: MCQ on DAX/logic (e.g., "What does ALL() do?").
- Project Reviews: Submit .pbix files + written insights.
- Peer Feedback: Critique dashboard usability.

## RECOMMENDED BOOKS

1. "The Definitive Guide to DAX" by *Marco Russo & Alberto Ferrari*
2. “Optimizing DAX” by Marco Russo & Alberto Ferrari

## COURSE OUTLINE

| Contents | Hours |
|---|---|
| 1. Power BI Basics | 4+12 |
| 1.1 Interface Overview | |
| 1.2 Data Loading | |
| 1.3 Data Transformations | |
| *Key Tools/Concepts: Power Query Editor, Data Model* | |
| 2. Data Modelling | 4+12 |
| 2.1 Relationships | |
| 2.2 Star Schema | |
| 2.3 DAX Basics | |
| *Key Tools/Concepts: Relationships view, CALCULATE()* | |
| 3. DAX Mastery | 4+12 |
| 3.1 Measures | |
| 3.2 Time Intelligence | |
| 3.3 Iterators | |
| *Key Tools/Concepts: SUMX(), DATEADD(), FILTER()* | |
| 4. Visualization | 4+12 |
| 4.1 Charts | |
| 4.2 Filters | |
| 4.3 Drill-throughs | |
| *Key Tools/Concepts: Visualizations pane, bookmarks* | |

5. Advanced Analytics 4+12
    5.1 Quick Measures
    5.2 Forecasting
    5.3 R/Python Integration
    *Key Tools/Concepts: AI visuals, custom visuals*
6. Dashboards 4+12
    6.1 Layouts
    6.2 Themes
    6.3 Mobile Optimization
    *Key Tools/Concepts: Dashboard design best practices*
7. Publishing & Sharing 4+12
    7.1 Power BI Service
    7.2 Apps
    7.3 Row-Level Security
    *Key Tools/Concepts: Workspaces, sharing permissions*
8. Real-World Projects 4+12
    8.1 End-to-End BI Solutions
    8.2 Data Cleaning, Modeling, Visualizations
    8.3 Insights & Reporting
    *Key Tools/Concepts: All concepts combined*

## List of Practical Exercises

Exercise 1:

- Power BI Basics
- Import a CSV (e.g., sales data) and clean it in Power Query:
    i. Remove duplicates.
    ii. Split columns (e.g., "Full Name" → "First/Last Name").
- Deliverable: A cleaned dataset loaded into Power BI.
    i. Data Modeling

Exercise 2:

- Build a star schema:
    i. Fact table: Sales
    ii. Dimension tables: Products, Customers, Dates.
- Create relationships (1:N, cross-filtering).
    i. DAX Formulas

Exercise 3:

- Write DAX measures:
    i. YoY Growth:

```
Sales YoY % =
VAR CurrentYearSales = [Total Sales]
VAR PriorYearSales = CALCULATE([Total Sales],
DATEADD('Date'[Date], -1, YEAR))
RETURN DIVIDE(CurrentYearSales – PriorYearSales,
PriorYearSales)
```

    ii. Top 10 Customers (using RANKX()).
    iii. Visualization

Exercise 4:

- Create a report page:
    i. Line chart: Monthly sales trends.
    ii. Matrix: Sales by product category.
    iii. Slicers for region/year.
    iv. Advanced Analytics

Exercise 5:

- Use the "Decomposition Tree" visual to analyze sales drivers.
- Add a Python/R script to cluster customers.
    i. Dashboards

Exercise 6:

- Design a mobile-friendly dashboard:

i. KPIs (Revenue, Profit Margin).
ii. Map visual for regional sales.
iii. Theme customization (fonts/colors).

Exercise 7:

- Publish to Power BI Service.
- Set up row-level security (RLS) so managers only see their region's data.

- Project 1: Build a financial dashboard:
  i. Profit & loss statement.
  ii. Cash flow forecasts.
- Project 2: Analyze retail data:
  i. Customer segmentation.
  ii. Inventory turnover metrics.

| | | T | P | C |
|---|---|---|---|---|
| COURSE CODE: | **AI-203** | | | |
| COURSE TITLE: | **AI Primer (ML, DL, Neural Networks)** | **1** | **3** | **2** |

To provide a holistic overview of the AI landscape, clearly differentiating and connecting the concepts of Machine Learning (ML), Deep Learning (DL), and the fundamental structure and function of Neural Networks.

## COURSE OBJECTIVE:

At the end of the course the students are expected to be able to:

- Compare and contrast Symbolic AI vs. Statistical AI.
- Differentiate between Supervised, Unsupervised, and Reinforcement Learning.
- Apply CRISP-DM (Cross-Industry Standard Process for Data Mining) methodology to ML projects.
- Grasp the statistical foundations for AI, including probability, distributions, and Bayes' Theorem.
- Understand the building blocks of neural networks: Perceptrons, Activation Functions, Loss, and Backpropagation.
- Identify the applications of different Deep Learning architectures, such as CNNs, RNNs, and Transformers.
- Apply principles of AI Ethics and Governance, including fairness, privacy, and using Explainable AI (XAI) techniques like SHAP and LIME

## COURSE DURATION:

| | | |
|---|---|---|
| Theory | 32 hours | one hour per week |
| Practical / Lab | 96 hours | one hour per week |

## TOOLS AND TECHNOLOGIES:

- Languages: Python
- Core Libraries: NumPy, Pandas, Scikit-learn, Matplotlib/Seaborn
- Deep Learning Frameworks: TensorFlow/Keras
- Explainable AI: SHAP, LIME

**DATASETS:**

- Iris Dataset: For classification basics.
- Titanic Dataset: For a complete EDA and predictive modeling pipeline.
- MNIST: For introduction to image classification with neural networks.

**REFERENCE BOOKS**

- "Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig
- "Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow" by Aurélien Géron

## COURSE OUTLINE

| Contents | Hours |
|---|---|
| 1. AI History & Philosophy | 4+12 |
| 1.1) Symbolic AI vs. Statistical AI, Turing Test, Ethics & Bias<br>Key Tools/Concepts: AI Taxonomy (ANI, AGI, ASI) | |
| 2. Machine Learning Fundamentals | 4+12 |
| 2.1 Supervised, Unsupervised, Reinforcement Learning, CRISP-DM<br>Key Tools/Concepts: Scikit-learn, Model Cards | |
| 3. Statistical Foundations for AI | 4+12 |
| 3.1 Probability, Distributions, Bayes' Theorem, Hypothesis Testing<br>Key Tools/Concepts: Python (SciPy, Statsmodels) | |
| 4. Introduction to Neural Networks | 4+12 |
| 4.1 Perceptrons, Activation Functions, Loss, Backpropagation<br>Key Tools/Concepts: Keras/TensorFlow, NumPy | |
| 5. Deep Learning Landscape | 6+16 |
| 5.1 Overview of CNNs, RNNs, Transformers, and their applications<br>Key Tools/Concepts: Understanding Algorithms | |

6. AI Project Lifecycle 6+16

6.1 Data sourcing, experimentation, MLOps, deployment
Key Tools/Concepts: MLflow, Weights & Biases

7. AI Ethics & Governance 4+12

7.1 Model interpretability (XAI), fairness, privacy, regulations
Key Tools/Concepts: SHAP, LIME

# LIST OF PRACTICAL EXERCISES

Exercise 1: Compare and contrast a simple rule-based system vs. a Decision Tree model on the Iris dataset.

Exercise 2: Implement a Perceptron from scratch using NumPy.

Exercise 3: Build a simple Feedforward Neural Network with Keras to classify handwritten digits (MNIST).

Exercise 4: Create a "Model Card" for your MNIST model, documenting its performance, limitations, and potential biases.

Exercise 5: Use SHAP to explain the predictions of a model on a tabular dataset (e.g., UCI Adult Income).

Exercise 6:

6.1 Simulate a large set of random data (e.g., 10,000 samples) and calculate its mean, median, and variance using NumPy and SciPy.

6.2 Plot the data's distribution (histogram) to visually verify its characteristics (e.g., if it follows a Normal Distribution).

Exercise 7: Bias-Variance Tradeoff Visualization

7.1 Use the Scikit-learn PolynomialFeatures to train polynomial regression models of increasing complexity (low degree, high degree) on a small dataset.

7.2 Visually demonstrate how low complexity leads to high bias (underfitting) and high complexity leads to high variance (overfitting).

Exercise 8: Backpropagation Walkthrough (Conceptual)

8.1. Manually calculate a single forward pass and the resulting loss for a 2-input, 1-output Perceptron given a set of weights and a known target value.

8.2. Use the calculated loss to perform the backpropagation step by manually calculating the change in weights (delta) for a single epoch.

Exercise 9: Model Deployment Snapshot

9.1. Train a small Scikit-learn model (e.g., Logistic Regression) and use the joblib library to serialize (save) the trained model to a file.

9.2. Write a basic function to load the saved model and use it to make a prediction on new, unseen data, simulating the first step of the deployment process.

Exercise 10: XAI for Feature Importance

10.1. Apply the LIME (Local Interpretable Model-agnostic Explanations) library to a prediction made by a Black-Box model (e.g., a Random Forest) on a tabular dataset.

10.2. Generate and analyze the resulting plot, identifying which specific features drove that individual prediction.

Exercise 11: Practical Features:

11.1. Hands-on Coding from Day 1: Every theoretical concept is immediately reinforced with code.

11.2. Model Cards & Documentation: Students learn to document their models' intended use, limitations, and biases, promoting responsible AI development.

| | | T | P | C |
|---|---|---|---|---|
| COURSE CODE: | **AI-204** | | | |
| COURSE TITLE: | **Machine Learning** | **1** | **3** | **2** |

Machine Learning (ML) is a branch of artificial intelligence that enables computers to learn patterns from data and make decisions without being explicitly programmed.

**COURSE OBJECTIVE:**

- Develop proficiency in the complete machine learning pipeline.
- Learn to frame ML problems effectively for real-world applications.
- Gain skills in data preparation, cleaning, and feature engineering.
- Train, evaluate, and optimize supervised and unsupervised ML models.
- Deploy ML models for prediction, classification, and decision-making tasks.

**COURSE DURATION:**

| | | |
|---|---|---|
| Theory | 32 hours | one hour per week |
| Practical / Lab | 96 hours | one hour per week |

**DATASETS:**

- House Prices (Regression)
- MNIST (Image Classification)
- Credit Card Fraud (Anomaly Detection)

**ASSESSMENT METHODS:**

- Model Cards: Documentation of ML experiments
- A/B Tests: Compare algorithm performance
- Deployment: Flask API submission

**TOOLS:**

- Scikit-learn/TensorFlow
- Weights & Biases (Experiment tracking)
- Google Colab Pro (GPU access)

**REFERENCE BOOKS**

**Core Textbook:**

- "Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow" (Aurélien Géron)

## COURSE OUTLINE

| Contents | | Hours |
|---|---|---|
| 1. | ML Fundamentals | 4+12 |
| 1.1. | Types of learning | |
| 1.2. | Bias-variance tradeoff | |
| 2. | Data Preprocessing | 4+12 |
| 2.1 | Feature engineering | |
| 2.2 | Feature scaling | |
| 3. | Supervised Learning | 4+12 |
| 3.1 | Regression | |
| 4. | Unsupervised Learning | 4+12 |
| 4.1 | Clustering | |
| 4.2 | Dimensionality reduction | |
| 5. | Model Evaluation | 4+12 |
| 5.1 | Evaluation metrics | |
| 5.2 | Cross-validation | |
| 6. | Neural Networks | 4+12 |
| 6.1 | Perceptrons | |
| 6.2 | Key Tools/Concepts: SHAP, LIME | |

| | | |
|---|---|---|
| 7. | Deployment | 4+12 |
| | 7.1 Model serialization | |
| | 7.2 API-based deployment | |
| 8. | Capstone Projects | 4+12 |
| | 8.1 End-to-end ML pipelines | |

## List of Practical Exercises

1. Compare manual vs ML predictions on toy datasets
2. Visualize bias-variance tradeoff with polynomial regression
3. Clean and normalize the Titanic dataset
4. Create custom features from timestamps (e.g., "time_of_day")
5. Predict house prices with linear regression
6. Build a spam classifier using Naive Bayes
7. Segment customers using K-means clustering
8. Reduce MNIST digits to 2D with PCA and visualize
9. Diagnose a failing model using confusion matrices
10. Optimize hyperparameters with GridSearchCV
11. Train a neural network to recognize handwritten digits
12. Visualize hidden layer activations
13. Package a model as a Flask API endpoint
14. Convert model to ONNX format
    - Option A: Predictive maintenance system
    - Option B: Real-time sentiment analysis engine

| | | T | P | C |
|---|---|---|---|---|
| COURSE CODE: | **AI-205** | | | |
| COURSE TITLE: | **Version Control Framework** | **1** | **3** | **2** |

Git is a widely used version control system that records every modification, making it easy to revert, compare, and manage code versions.

## COURSE OBJECTIVE:

- Understand best practices for code and project management using Git and GitHub.
- Learn to track changes, maintain version history, and ensure project integrity.
- Collaborate effectively using branches, pull requests, and merge workflows.
- Apply version control techniques to manage and safeguard data science and software projects.

**COURSE DURATION:**

| | | |
|---|---|---|
| Theory | 32 hours | one hour per week |
| Practical / Lab | 96 hours | one hour per week |

**PRACTICE PROJECTS:**

- Contribute to first-contributions repo
- Team-based markdown documentation
- Simulate merge conflicts

**ASSESSMENT:**

- Weekly CLI drills (30%)
- PR reviews (30%)
- Capstone: CI/CD pipeline (40%)

**TOOLS:**

- GitHub Learning Lab (interactive)
- GitLens (VS Code)
- GitHub Classroom (auto-grading)

**REFERENCE BOOK**

1. "Pro Git" by Scott Chacon (Free online)

# COURSE OUTLINE

| Contents | | Hours |
|---|---|---|
| 1. | **Git Fundamentals** | 4+12 |
| | 1.1 Version control concepts | |
| | 1.2 Basic Git commands | |
| 2. | **Branching Strategies** | 4+12 |
| | 2.1 Feature branches | |
| | 2.2 Merging strategies | |
| 3. | **Remote Repositories** | 4+12 |
| | 3.1 GitHub integration | |
| | 3.2 GitHub integration | |
| 4. | **Conflict Resolution** | 4+12 |
| | 4.1 Identifying merge conflicts | |
| | 4.2 Resolving conflicts | |
| 5. | **GitHub Features** | 4+12 |
| | 5.1 Issues | |
| | 5.2 Projects | |
| | 5.3 GitHub Actions | |
| 6. | **Advanced Git** | 4+12 |
| | 6.1 Rebasing | |
| | 6.2 Tagging | |
| | 6.3 Git hooks | |
| 7. | **Team Workflows** | 4+12 |
| | 7.1 Pull Request reviews | |
| | 7.2 CODEOWNERS workflow | |
| 8. | **Capstone Projects** | 4+12 |
| | 8.1 Collaborative development simulation | |

# LIST OF PRACTICAL EXERCISES

1. Create a local repo and make your first commit
2. Travel through commit history with git log
3. Implement a new feature in an isolated branch
4. Practice three-way merges
5. Mirror a local repo to GitHub
6. Clone an open-source project
7. Intentionally create and resolve merge conflicts
8. Use git bisect to find a bug
9. Create an Issue and link it to a PR
10. Set up a basic GitHub Action
11. Rewrite history with interactive rebase
12. Create annotated tags for releases
13. Conduct a peer code review via PR
14. Configure branch protection rules
    - Option A: Contribute to an open-source project
    - Option B: Simulate a team project with CI/CD

# SYLLABI

# DAE IN ARTIFICIAL INTELLIGENCE

# THIRD YEAR

| | | T | P | C |
|---|---|---|---|---|
| COURSE CODE: | **GEN-311** | | | |
| COURSE TITLE: | **Islamiat / Pak Studies** | **1** | **0** | **1** |

یہ کورس طلباء کو اسلامیات اور مطالعہ پاکستان کے بنیادی اصولوں اور تصورات سے روشناس کراتا ہے۔ اس کا مقصد طلباء میں دینی اور قومی شعور کو اجاگر کرنا اور انہیں ملک کے نظریاتی اور تاریخی پس منظر سے واقف کرانا ہے۔

**COURSE OBJECTIVE:** **کورس کے متوقع مقاصد**

**Part 1: Islamiat**

<u>موضوعات:</u>

**قرآن مجید:**

- سورۃ الفاتحہ، آیت الکرسی، سورہ بقرہ کی آخری آیات (آمن الرسول) اور سورہ اخلاص مع ترجمہ و تشریح۔

**<u>تدریس مقاصد</u>**:

**1. قرآن حکیم:**

<u>عمومی مقصد</u>: منتخب سورتوں اور آیات کی روشنی میں اسلام کے بنیادی مقاصد اور عبادات جان سکے۔

<u>خصوصی مقاصد</u>: طالب علم اس قابل ہو جائے کہ :

- سورۃ الفاتحہ، آیت الکرسی، سورہ بقرہ کی آخری آیات اور سورہ اخلاص کا ترجمہ و تشریح کر سکے۔
- رب العالمین صرف اللہ تعالٰی ہے۔
- اللہ رحم کرنے والا ہے۔
- قیامت کے دن بادشاہی اللہ کی ہوگی۔
- عبادت اور استعانت کا حقدار صرف اللہ ہے۔

طالب علم درج ذیل کا مفہوم بیان کر سکے:

- اللہ پاک ہر عیب سے پاک ہے۔
- اللہ کے اسمائے حسنٰی حق اور قیوم ہیں۔
- تعلیم انبیاء پر ایمان لانا ضروری ہے۔
- رسولوں، ملائکہ اور کتب سماویہ پر ایمان لانا فرض ہے۔
- اطاعتِ حقیقی صرف اللہ کے لیے ہے۔
- اسلامی احکامات پر عمل کرنا انسانی بھلائی میں ہے۔
- کفر کو اللہ کی مدد کے بغیر شکست نہیں دی جا سکتی۔
- اللہ ایک ہے۔
- اللہ کسی کا محتاج نہیں نہ اس کا کوئی شریک ہے۔

**2. منتخب احادیث:**

- عمومی مقصد: احادیث کی روشنی میں اسلامی تعلیمات پر عمل پیرا ہو سکے۔
- خصوصی مقصد:
  - احادیث کا ترجمہ بیان کر سکے۔
  - احادیث کی تشریح کر سکے۔
  - معاشرتی اور انفرادی زندگی میں احادیث سے رہنمائی حاصل کر سکے۔

## 3. حقوق و فرائض

عمومی مقصد: اسلامی معاشرے کا ایک اچھا فرد بن سکے۔

خصوصی مقاصد:

- والدین کے حقوق و فرائض بیان کر سکے۔
- ہمسایوں کے حقوق بیان کر سکے۔
- اسلام میں حقوق و فرائض کی اہمیت کی صورت میں اپنے اندر خدمتِ خلق کا جذبہ پیدا کر سکے۔

## 4. اسلامی اقدار

عمومی مقصد: طالب علم جان سکے کہ تعلیم کا مقصد حسنِ اخلاق سے متصف ہونا ہے۔

خصوصی مقاصد:

- اخلاق کے معنی و مفہوم کو بیان کر سکے۔
- اسلام میں حسنِ اخلاق کی اہمیت بیان کر سکے۔
- قرآن و سنت کی روشنی میں صبر و استقلال کی اہمیت بیان کر سکے۔
- اسلام میں عفو و درگزر کی اہمیت بیان کر سکے۔
- ایفائے عہد کی اہمیت بیان کر سکے۔
- اخوت کے معنی و مفہوم کو بیان کر سکے۔
- اخوتِ اسلامی کی اہمیت بیان کر سکے۔
- اسلام کی اعلیٰ اقدار کو اپنا کر مثالی معاشرہ پیدا کر سکے۔

| | | T | P | C |
|---|---|---|---|---|
| COURSE CODE: | **GEN-311** | | | |
| COURSE TITLE: | **Islamiat / Pak Studies** | **1** | **0** | **1** |

یہ کورس طلباء کو اسلامیات اور مطالعہ پاکستان کے بنیادی اصولوں اور تصورات سے روشناس کراتا ہے۔ اس کا مقصد طلباء میں دینی اور قومی شعور کو اجاگر کرنا اور انہیں ملک کے نظریاتی اور تاریخی پس منظر سے واقف کرانا ہے۔

**COURSE OBJECTIVE:** **کورس کے متوقع مقاصد**

**Part 2: Pakistan Studies**

## 1. قیامِ پاکستان

**تدریسی مقاصد**

عمومی مقاصد: قیامِ پاکستان کے بعد درپیش مسائل سے آگاہی حاصل کرے اور بیان کرے۔

خصوصی مقاصد:

- باؤنڈری کمیشن تشکیل اور اس کے فرائض بیان کر سکے۔
- ریڈ کلف اور اس کے ایوارڈ کے بارے میں بیان کر سکے۔
- بنگال اور کلکتہ کی تقسیم کی وجوہات بیان کر سکے۔
- پنجاب کی تقسیم کی تفصیل بیان کر سکے۔
- مہاجرین کی آمد سے جو مسائل پیدا ہوئے انہیں بیان کر سکے۔
- ریاستوں کے الحاق کے بارے میں تفصیل بیان کر سکے۔
- ریاست جموں و کشمیر کے بارے میں بیان کر سکے۔
- نہری پانی کے تنازعہ کو بیان کر سکے۔
- قراردادِ مقاصد کی تفصیلات بیان کر سکے۔
- 22 علماء کے متفقہ اسلامی نکات بیان کر سکے۔
- قیامِ پاکستان کے بعد نفاذِ اسلام کی کوششوں کو بیان کر سکے۔
- پاکستان کے محل وقوع اور اس کی جغرافیائی اہمیت بیان کر سکے۔
- پاکستان میں قدرتی وسائل (تیل، گیس، کوئلہ) کے بارے میں بیان کر سکے۔

## موضوعات

- قیامِ پاکستان
- باؤنڈری کمیشن
- ریڈ کلف ایوارڈ
- تقسیمِ بنگال و کلکتہ
- تقسیمِ پنجاب
- مسئلہ مہاجرین
- ریاست کا الحاق
- ریاست جموں و کشمیر
- نہری پانی کا تنازعہ
- قراردادِ مقاصد
- علماء کے بائیس نکات
- 1956، 1962 اور 1973 کے دساتیر کی اسلامی دفعات
- پاکستان کا محلِ وقوع اور اس کی جغرافیائی اہمیت
- قدرتی وسائل (تیل، گیس، کوئلہ)

| | | T | P | C |
|---|---|---|---|---|
| COURSE CODE: | **GEN-311** | | | |
| COURSE TITLE: | **Islamiat / Pak Studies(Non-Muslims)** | **1** | **0** | **1** |

## COURSE OBJECTIVE: کورس کے متوقع مقاصد

عمومی مقصد: ملکی ترقی کے لیے اعلٰی اوصاف کے ساتھ بہتر طور پر ملک و ملت کی خدمت کر سکے۔

خصوصی مقاصد: طالب علم اس قابل ہو گا کہ:

- موضوعات کا مطلب بیان کر سکے۔
- عملی زندگی سے مثالوں کی نشاندہی کر سکے۔
- موضوعات کی اہمیت بیان کر سکے۔
- اپنی شخصیت اور معاشرے پر موضوعات کے مطابق اثرات پیدا کرنے کے طریقے بیان کر سکے۔
- مثبت ذہن کے ساتھ کام کر سکے۔
- عدل و انصاف سے ادارہ میں، دفتر میں بہتر ماحول پیدا کر سکے۔
- ماحول کو اخلاقی طور پر پاکیزہ بنائے۔
- کارکنوں کی بہتر طور پر دل جوئی کر سکے۔
- کارکردگی میں اضافہ کر سکے۔
- باہمی احترام کی برکات سے استفادہ کر سکے۔

## موضوعات:

- احساسِ ذمہ داری
- مثبت ذہن
- عدل و انصاف
- قومی خدمت کا جذبہ
- ذکر و فکر کی پاکیزگی
- احترامِ آدمیت
- شائستگی
- عفو و درگزر
- بردباری
- خود انحصاری
- اثر و نفوذ
- جامعیت
- اپنی ذات کی معرفت (بذریعہ ہم عمر طلباء، اساتذہ، اہم شخصیات، ادارہ)

| Course Code: | **MGT 331** | **T** | **P** | **C** |
|---|---|---|---|---|
| Course Title: | **Management** | **1** | **0** | **1** |

Introductory course on business management. It aims to prepare students to work effectively in business and industry. It discusses basic economics principles and organization management as well as skills in becoming an entrepreneur. It is pure class discussion.

## Course Objectives

At the end of the course the students are expected to be able to

- Understand the basic concepts and principles of economics, business management and organization.
- Apply management concepts in business organization
- Use economic principles and business management to organize own business
- Recognize the importance of economics and management in daily life

## LEARNING OBJECTIVES

**1. Economics**

1.1. Understand the Importance of Economics.
1.2. State definition of economics
1.3. Explain nature and scope of economics.
1.4. Describe importance of study of economics for technicians.

**2. Basic Concepts of Economics**

2.1. Understand Basic Terms Used in Economics
2.2. Define basic terms, utility, income, wealth, saving, investment and value.
2.3. Explain the basic terms with examples

**3. Demand and Supply**

3.1. Understand Law of Demand and Law of Supply
3.2. Define Demand and Supply
3.3. Explain the law of demand with the help of a schedule and diagram.
3.4. State assumptions and limitation of law of demand.
3.5. Explain the law of Supply with the help of schedule and diagram.
3.6. State assumptions and limitation of law of supply.

**4. Factors of Production**

4.1. Understand the Factors of Production
4.2. Define the four factors of production.
4.3. Explain labour and its features.
4.4. Describe capital and its peculiarities.

**5. Business Organization**

5.1. Understand Forms of Business Organization
5.2. Describe sole proprietorship, its merits and demerits.
5.3. Explain partnership, its advantages and disadvantages.
5.4. Describe a joint stock company, its merits and demerits.
5.5. Distinguish public limited company and private limited company.

**6. Entrepreneurial Skills**

6.1. Understand Entrepreneurial Skills
6.2. Explain preparing, planning, establishing and managing small business
6.3. Explain evaluating all relevant resources
6.4. Describe organizing analyzing and innovation of risk of task

**7. Scale of Production**

7.1. Understand Scale of Production
7.2. Explain scale of production and its determination.
7.3. Describe large-scale production and its merits.
7.4. Explain small scale of production and its advantages and disadvantages.

**8. Economic System**

8.1. Understand Different Economic Systems
8.2. Describe a free economic system and its characteristics.
8.3. Explain a centrally planned economic system, its merits and demerits.
8.4. State mixed economic system and its features.

**9. Money**

9.1. Understand What Is Money
9.2. Define money
9.3. Explain the barter system and its inconveniences.
9.4. Explain functions of money.

**10. Bank**

10.1. Understand Bank and Its Functions
10.2. Define a bank.
10.3. Describe commercial banks and their functions.
10.4. State central bank and its functions.

**11. Cheque**

11.1. Understand Cheque and Dishonor of Cheque
11.2. Define cheque.
11.3. Enlist the characteristics of cheque.
11.4. Identify the kinds of cheque.
11.5. Describe the causes of dishonor of a cheque.

**12. Financial Institutions**

12.1. Understand Financial Institutions
12.2. Explain IMF and its objectives.
12.3. Explain organizational set up and objectives of IDBP.
12.4. Explain organizational set up and objectives of PIDC.

**13. Trade Union**

13.1. Understand Trade Union, Its Background and Functions
13.2. Describe brief history of trade union.
13.3. State functions of trade unions.
13.4. Explain objectives, merits and demerits of trade unions.
13.5. Enlist problems of industrial labour.

**14. International Trade**

14.1. Understand International Trade
14.2. Explain international trade.
14.3. Enlist its merits and demerits.

**15. Management**

15.1. Understand Management
15.2. Explain meaning of management.
15.3. Describe functions of management.
15.4. Identify the problems of business management.

**16. Advertisement**

16.1. Understand Advertisement
16.2. Explain the concept of advertisement.
16.3. Enlist benefits and drawbacks of advertisement.
16.4. Describe principal media of advertisement used in the business world.

**17. Economy of Pakistan**

17.1. Understand the Economic Problems of Pakistan.
17.2. Describe economy of Pakistan
17.3. Explain economic problems of Pakistan
17.4. Explain remedial measures for economic problems of Pakistan

## COURSE OUTLINE(Total Hours: 32)

| Contents | Hours |
|---|---|
| **1. Economics** | **2** |
| 1.1. Definition: Adam Smith, Alfred Marshall, Prof. Robins<br>1.2. Nature and scope<br>1.3. Importance for Technicians | |
| **2. Basic Concepts of Economics** | **1** |
| 2.1. Utility<br>2.2. Income<br>2.3. Wealth<br>2.4. Saving | |

2.5. Investment
2.6. Value.

**3. Demand and Supply** **2**

3.1. Definition of Demand
3.2. Law of Demand
3.3. Definition of Supply
3.4. Law of Supply

**4. Factors of Production** **2**

4.1. Land
4.2. Labour
4.3. Capital
4.4. Organization

**5. Business Organization** **3**

5.1. Sole Proprietorship
5.2. Partnership
5.3. Joint Stock Company

**6. Entrepreneurial Skills** **4**

6.1. Preparing, Planning, Establishing, Managing, Operating and Evaluating
6.2. Relevant Resources in Small Business
6.3. Business Opportunities, Goal Setting
6.4. Organizing, Evaluating and Analyzing Opportunity and Risk Tasks

**7. Scale of Production**
**2**

7.1. Meaning and its Determination
7.2. Large Scale Production
7.3. Small Scale Production

**8. Economic System** **3**

8.1. Free Economic System.
8.2. Centrally planned economy.
8.3. Mixed Economic System

**9. Money** **1**

9.1. Barter System and its Inconveniences

9.2. Definition of Money and its Functions

**10. Bank** **1**

10.1. Definition
10.2. Functions of a Commercial Bank
10.3. Central Bank and its Functions

**11. Cheque** **1**

11.1. Definition
11.2. Characteristics and Kinds of cheque
11.3. Dishonour of Cheque

**12. Financial Institutions** **2**

12.1. IMF
12.2. IDBP
12.3. PIDC

**13. Trade Union** **2**

13.1. Introduction and Brief History
13.2. Objectives, Merits and Demerits
13.3. Problems of industrial Labour

**14. International Trade** **2**

14.1. Introduction
14.2. Advantages and Disadvantages

**15. Management** **1**

15.1. Meaning
15.2. Functions

**16. Advertisement** **2**

16.1. The Concept, Benefits and Draw-Backs
16.2. Principal Media Used In Business World

**17. Economy of Pakistan** **1**

17.1. Introduction
17.2. Economic Problems and Remedies

**References**

1. Business Organization, Nisar-ud-Din, Aziz Publisher, Lahore
2. Introduction to Business, M. Saeed Nasir, , Ilmi Kitab Khana, Lahore.
3. An Introduction to Modern Economics, S.M. Akhtar, , United Limited, Lahore.

| | | T | P | C |
|---|---|---|---|---|
| COURSE CODE: | **ENG 311** | | | |
| COURSE TITLE: | **TECHNICAL REPORT WRITING** | **1** | **0** | **1** |

Third English course in this technology program. It aims to provide students with the opportunity to sharpen their skills in using the English language through writing technical reports. It covers the basics of technical writing, techniques, document design, applications of technical writing and oral reports. It is a theory class.

## Course Objectives

At the end of the course the students are expected to be able to

- Understand the basic techniques of technical writing.
- Use these techniques to write readable technical report
- Compose and write technical reports
- Present effective oral reports
- Write legibly in English language
- Integrate English language as second language

## LEARNING OBJECTIVES

### 1. Introduction to Technical Writing

1.1. Differentiate technical writing from other forms of writing
1.2. Describe the nature of technical writing
1.3. List the characteristics of good technical writer
1.4. Describe the qualities of good technical writing

### 2. Fundamentals of Technical Writing

2.1. Compose good technical report
2.2. Identify the topic and purpose of a technical writing
2.3. Draft and revise technical report
2.4. Use fundamentals of technical writing to write good report
2.5. Plan a technical writing with several writers
2.6. Identify different readers of technical writers
2.7. Search literature for topics in technical writing
2.8. Write letter of inquiry
2.9. Write report with list and tables
2.10. Compose technical report that is grammatically correct and readable

**3. Techniques of Technical Writing**

3.1. Write readable report that informs
3.2. Use visual language, analogy, and process description to write technical report
3.3. Write readable reports that define and describe
3.4. Write readable report that describe a process
3.5. Write readable and persuasive report that argue
3.6. Compose technical writing that persuade

**4. Document Design in Technical Writing**

4.1. Use correct formatting for technical writing
4.2. List the elements of a report
4.3. Describe each element of a report
4.4. Write report that has all the elements of report
4.5. Use correctly documentation formats in technical writing

**5. Application of Technical Writing**

5.1. Identify different forms of technical writing
5.2. Write readable correspondence
5.3. Write readable Instructions
5.4. Write readable proposals
5.5. Write readable progress report
5.6. Write feasibility report

**6. Oral Reports**

6.1. Describe elements in preparing an oral report
6.2. Identify different techniques of oral delivery of report
6.3. Present report with visual aids

## COURSE OUTLINE (Total Hours: 32)

| Contents | Hours |
|---|---|
| **1. Introduction to Technical Writing** | **2** |
| 1.1. Substance of Technical Writing<br>1.2. Nature of Technical Writing<br>1.3. Qualities of Good Technical Writers<br>1.4. Qualities of Good Technical Writing | |
| **2. Fundamentals of Technical Writing** | **6** |
| 2.1. Composing<br>2.2. Cooperative Writing<br>2.3. Readers of Technical Writing<br>2.4. Collecting and Verifying Information<br>2.5. Readable Style | |
| **3. Techniques of Technical Writing** | **6** |
| 3.1. Informing<br>3.2. Defining<br>3.3. Describing<br>3.4. Arguing | |
| **4. Document Design in Technical Writing** | **6** |
| 4.1. Document Design<br>4.2. Design Elements of Reports<br>4.3. Graphical Elements of Reports | |
| **5. Application of Technical Writing** | **8** |
| 5.1. Correspondence<br>5.2. Instructions<br>5.3. Proposals<br>5.4. Progress Report<br>5.5. Feasibility Report | |

**6. Oral Reports** **4**

6.1. Preparations
6.2. Delivery Techniques
6.3. Presentation
6.4. Visual Aids

**References**

1. Reporting Technical Information, 7Ed., K. Houp, T. Pearsall, et. al., MacMillan
2. Writing by Design, A Handbook for Technical Papers, M. Greene, J. Ripley, Prentice Hall
3. Strategies for Technical Writing, A Handbook with Readings, M. Lay, Holt Rinehart Winston

| | | T | P | C |
|---|---|---|---|---|
| COURSE CODE: | **AI-301** | | | |
| COURSE TITLE: | **Cloud Providers (Emerging Technologies)** | **1** | **3** | **2** |

To equip students with foundational skills in cloud computing by providing hands-on experience with AWS, Azure, and GCP, covering deployment, management, scaling, cost, and security.

## COURSE OBJECTIVE:

At the end of the course the students are expected to be able to:

- Understand the cloud service models (IaaS/PaaS/SaaS) and the shared responsibility model.
- Deploy and manage Virtual Machines, containers, and serverless functions on all three major platforms (AWS, Azure, GCP).
- Utilize and configure object, block, and file storage solutions (e.g., S3, Blob Storage, Cloud Storage).
- Set up and configure basic networking components like Virtual Private Clouds (VPCs), load balancers, and CDNs.
- Deploy managed Relational and NoSQL databases (e.g., RDS, Cosmos DB, Cloud Spanner).
- Implement secure access control using IAM (Identity and Access Management) services across platforms.
- Automate deployment and infrastructure using Infrastructure as Code (IaC) tools like Terraform.
- Monitor resources, set up CI/CD pipelines, and configure auto-scaling.

## COURSE DURATION:

| | | |
|---|---|---|
| Theory | 32 hours | one hour per week |
| Practical / Lab | 96 hours | one hour per week |

## DATASETS:

- NOAA Weather Data (AWS S3)
- NYC Taxi Trips (Azure)
- Google Analytics Sample (GCP)

**ASSESSMENT METHODS:**

- Lab Reports: Screenshots + Terraform code
- Architecture Diagrams: Draw.io/Lucidchart submissions
- Cost Analysis: Estimate project spend

**TOOLS:**

- Terraform (IaC)
- CloudShell (AWS/Azure/GCP)
- CloudHealth (Cost monitoring)

**REFERENCE BOOKS:**

- **"Cloud Architecture Patterns" (Microsoft Press)** – Multi-cloud design

## COURSE OUTLINE

| Contents | Hours |
|---|---|
| 1. Cloud Fundamentals | 4+12 |
| 1.1) IaaS/PaaS/SaaS, shared responsibility model | |
| 1.2) Key Tools/Concepts: AWS/Azure/GCP consoles | |
| 2. Compute Services | 4+12 |
| 2.1) Virtual machines, containers, serverless | |
| 2.2) Key Tools/Concepts: EC2, Azure VMs, GCE, Lambda, Functions | |
| 3. Storage Solutions | 4+12 |
| 3.1) Object, block, file storage | |
| 3.2) Key Tools/Concepts: S3, Blob Storage, Cloud Storage | |

4. Networking 4+12

4.1) VPCs, load balancing, CDNs

4.2) Key Tools/Concepts: VPC, Azure Virtual Network, Cloud DNS

5. Databases 4+12

5.1) Relational & NoSQL options

5.2) Key Tools/Concepts: RDS, Cosmos DB, Cloud Spanner

6. Security & IAM 4+12

6.1) Identity management, encryption

6.2) Key Tools/Concepts: IAM, Azure AD, Cloud IAM

7. DevOps & Monitoring 4+12

7.1) CI/CD, logging, auto-scaling

7.2) Key Tools/Concepts: Cloud Build, Azure DevOps, CloudWatch

8. Capstone Projects 4+12

8.1) Multi-cloud deployments

8.2) Key Tools/Concepts: All concepts combined

## List of Practical Exercises

1. Create accounts on AWS/Azure/GCP (free tier)
2. Compare pricing calculators for sample workloads
3. Launch a Linux VM on each platform
4. Deploy a serverless function (Python)
5. Upload files to object storage and set permissions
6. Configure cross-region replication
7. Set up a VPC with public/private subnets
8. Configure a load balancer
9. Deploy a managed PostgreSQL database
10. Migrate local SQLite data to cloud
11. Implement role-based access control (RBAC)
12. Encrypt a storage bucket
13. Automate deployment with Terraform
14. Set up CPU-based auto-scaling
15. Project

    Option A: Host a scalable web app

    Option B: Build a data pipeline

| | | T | P | C |
|---|---|---|---|---|
| COURSE CODE: | **AI-302** | | | |
| COURSE TITLE: | **R Programming** | **1** | **3** | **2** |

To gain competency in the R programming language for statistical computing, focusing on data manipulation, advanced statistical analysis, and creating publication-quality visualizations for data exploration and reporting

## COURSE OBJECTIVE:

At the end of the course the students are expected to be able to:

- Navigate the R Ecosystem and master core data structures (vectors, lists, data.frames).
- Apply the Tidyverse Paradigm for a consistent and powerful grammar of data manipulation and visualization.
- Perform powerful data wrangling using dplyr (filter, select, mutate, group_by) and tidyr (pivot).
- Utilize ggplot2 to create advanced, publication-quality data visualizations based on the grammar of graphics.
- Build and interpret fundamental statistical models like Linear and Logistic Regression.
- Train modern Machine Learning models (Random Forests, Gradient Boosting) and evaluate them using the caret package.
- Create dynamic and well-documented reports for reproducible research using R Markdown.
- Develop and deploy interactive web applications from R using the Shiny framework.

## COURSE DURATION:

| | | |
|---|---|---|
| Theory | 32 hours | one hour per week |
| Practical / Lab | 96 hours | one hour per week |

## PRACTICAL FEATURES:

- The Tidyverse Paradigm: Emphasis on a consistent and powerful grammar for data manipulation and visualization.
- Reproducible Research: All work is done in R Markdown, ensuring analyses are well-documented and repeatable.

## ASSESSMENT METHODS:

- Tidyverse Data Wrangling Challenge (25%): A timed assignment to clean and reshape a messy real-world dataset.
- EDA Report (25%): A complete R Markdown report exploring a complex dataset with ggplot2 visualizations and insights.

## TOOLS AND TECHNOLOGIES:

- IDE: RStudio
- Core Libraries: tidyverse (dplyr, ggplot2, tidyr, readr), caret, shiny, rmarkdown
- Advanced Modeling: xgboost, randomForest, broom
- Deployment: shinyapps.io, RStudio Connect

## DATASETS:

- Diamonds Dataset (ggplot2): For mastering advanced data visualization.
- Customer Churn Data: For logistic regression and classification model evaluation.

## REFERENCE BOOKS

- **"R for Data Science"** by Hadley Wickham and Garrett Grolemund

## COURSE OUTLINE

| Contents | Hours |
|---|---|
| 1. The R Ecosystem | 4+12 |
| 1.1 RStudio, tidyverse, data structures (vectors, lists, data.frames) | |
| Key Tools/Concepts: tidyverse | |
| 2. Data Wrangling with Tidyverse | 4+12 |
| 2.1 dplyr (filter, select, mutate, group_by), tidyr (pivot) | |
| Key Tools/Concepts: dplyr, tidyr | |

3. Advanced Data Visualization 4+12

3.1 ggplot2 grammar of graphics: layers, scales, facets

Key Tools/Concepts: ggplot2

4. Statistical Modeling 4+12

4.1 Linear & Logistic Regression, Hypothesis Testing, ANOVA

Key Tools/Concepts: Base R, broom

5. Machine Learning in R 4+12

5.1 Random Forests, Gradient Boosting, Model Evaluation with caret

Key Tools/Concepts: caret, xgboost

6. R Markdown for Reproducibility 6+16

6.1 Creating dynamic reports and presentations

Key Tools/Concepts: R Markdown, knitr

7. Communication with Shiny 6+16

7.1 Building interactive web applications from R

Key Tools/Concepts: Shiny

# LIST OF PRACTICAL EXERCISES

Exercise 1: Perform a full exploratory data analysis (EDA) on the diamonds dataset using dplyr and ggplot2.

Exercise 2: Build and interpret a logistic regression model to predict customer churn.

Exercise 3: Train a Random Forest model using the caret package, performing hyperparameter tuning and cross-validation.

Exercise 4: Create a reproducible report in R Markdown that presents your churn analysis.

Exercise 5: Build a simple Shiny app that allows users to interactively explore a dataset.

Exercise 6: Advanced Tidyverse Reshaping

6.1 Take a dataset in wide format (where columns represent variables and values, e.g., monthly sales for 2021, 2022, 2023) and use tidyr::pivot_longer() to convert it to long format.

6.2 Take a dataset in long format (e.g., student grades with separate rows for each subject) and use tidyr::pivot_wider() to summarize it into a wide format.

Exercise 7: Geospatial Visualization with ggplot2 and sf

7.1 Load a dataset containing geographical coordinates or shapefiles (e.g., US state boundaries using the sf package).

7.2 Create a choropleth map using ggplot2's geometry layers (geom_sf) to visualize a variable (like population density or income) across different regions.

Exercise 8: Time Series Forecasting

8.1 Load a time-series dataset (e.g., historical stock prices or monthly sales data) and convert it to a time-series object.

8.2 Fit a basic forecasting model (e.g., ARIMA or ETS using the forecast package).

8.3 Plot the historical data along with the next 12-month forecast and its confidence intervals using autoplot().

Exercise 9: Model Interpretation with broom

9.1 Fit a multiple linear regression model (using base R or lm()).

9.2 Use the broom::tidy() function to easily extract, summarize, and tabulate the model's coefficients, standard errors, and p-values into a clean data frame for reporting.

Exercise 10: Building a Flexible Dashboard in R Markdown

10.1 Create a single R Markdown document that incorporates interactive features (e.g., a slider or dropdown menu using the flexdashboard or runtime: shiny options).

10.2 Allow the user to select a variable and dynamically update a ggplot2 visualization based on their input, without requiring a full Shiny application setup.

| | | T | P | C |
|---|---|---|---|---|
| COURSE CODE: | **AI-303** | | | |
| COURSE TITLE: | **Natural Language Processing** | **1** | **3** | **2** |

To unlock the ability to process and analyze human language data by learning key techniques like tokenization, sentiment analysis, and entity recognition, and to build simple conversational agents.

## COURSE OBJECTIVE:

At the end of the course the students are expected to be able to:

- Perform text preprocessing steps including tokenization, stemming, and lemmatization.
- Convert text into numerical representations using methods like Bag-of-Words, TF-IDF, and Word Embeddings (Word2Vec, GloVe).
- Implement traditional NLP tasks such as Sentiment Analysis and Topic Modeling (LDA).
- Understand the Attention Mechanism and the architecture of modern models like BERT.
- Apply state-of-the-art Transformer models for tasks like Text Classification and Named Entity Recognition (NER).
- Utilize Prompt Engineering and Parameter-Efficient Fine-Tuning (PEFT) to adapt LLMs.
- Build practical NLP applications such as chatbots and document summarization tools.

## COURSE DURATION:

| | | |
|---|---|---|
| Theory | 32 hours | one hour per week |
| Practical / Lab | 96 hours | one hour per week |

## PRACTICAL FEATURES:

- Pipeline Progression: Move from traditional methods (Bag-of-Words) to modern transformers, understanding the trade-offs.
- Hugging Face Ecosystem Mastery: Heavy use of the transformers and datasets libraries as the industry standard.

## ASSESSMENT METHODS:

- Model Comparison Report (20%): Compare the performance of a classical model (e.g., SVM with TF-IDF) vs. a fine-tuned transformer on a specific task.
- Fine-tuning Assignment (30%): Fine-tune a BERT-based model on a custom dataset for a task like NER or sentiment analysis.

**TOOLS AND TECHNOLOGIES:**

- Core Libraries: NLTK, spaCy, Gensim, Scikit-learn
- Transformers & LLMs: Hugging Face transformers, datasets, accelerate, peft
- Frameworks: LangChain, LlamaIndex
- Deployment: FastAPI, Streamlit, Docker
- APIs: OpenAI API, Cohere API

**DATASETS**:

- IMDb Movie Reviews: For sentiment analysis.
- Twitter Airline Sentiment: For real-world, noisy text classification.
- CoNLL-2003: For Named Entity Recognition (NER).

**REFERENCE BOOKS:**

- "Speech and Language Processing" by Daniel Jurafsky and James H. Martin
- "Natural Language Processing with Transformers" by Lewis Tunstall, Leandro von Werra, and Thomas Wolf

## COURSE OUTLINE

| Contents | Hours |
|---|---|
| 1. Text Preprocessing | 4+12 |
| ● Tokenization, stemming, lemmatization, stop-word removal<br>○ Key Tools/Concepts: NLTK, spaCy | |
| 2. Text Representation | 4+12 |
| ● Bag-of-Words, TF-IDF, Word Embeddings (Word2Vec, GloVe)<br>○ Key Tools/Concepts: Scikit-learn, Gensim | |

3. Traditional NLP Tasks 4+12

- Sentiment Analysis, Topic Modeling (LDA), Text Classification
    - Key Tools/Concepts: NLTK, Gensim

4. Introduction to Transformers 4+12

- Attention Mechanism, BERT architecture, Tokenizers

    Key Tools/Concepts: Hugging Face `transformers`

5. Transformer Applications 4+12

- Text Classification, Named Entity Recognition (NER), Question Answering
    - Key Tools/Concepts: Hugging Face Hub

6. Advanced LLM Techniques 6+16

- Prompt Engineering, Fine-tuning LLMs, Parameter-Efficient Fine-Tuning (PEFT)
    - Key Tools/Concepts: OpenAI API, Hugging Face PEFT

7. Building NLP Applications 6+16

- Chatbots, Document Summarization, Deployment
    - Key Tools/Concepts: LangChain, FastAPI

# LIST OF PRACTICAL EXERCISES

Exercise 1: Perform sentiment analysis on movie reviews using both a Bag-of-Words model and a pre-trained transformer model, comparing results.

Exercise 2: Train a Word2Vec model on a custom corpus and explore the semantic relationships.

Exercise 3: Fine-tune a BERT model for a specific NER task using the Hugging Face ecosystem.

Exercise 4: Build a retrieval-augmented generation (RAG) chatbot using LangChain and a vector database.

Exercise 5: Create a FastAPI endpoint that serves a text summarization model.

Exercise 6: Advanced Text Preprocessing and Tokenization

6.1 Use the spaCy library to perform dependency parsing and part-of-speech (POS) tagging on a sample set of complex sentences.

6.2 Compare the tokens generated by a classical NLTK word tokenizer versus a Transformer model tokenizer (which handles sub-words) on a piece of text containing specialized vocabulary (e.g., medical or legal jargon).

Exercise 7: Unsupervised Topic Modeling with LDA

7.1 Apply Latent Dirichlet Allocation (LDA), typically using the Gensim library, to a large corpus of unstructured text (e.g., news articles or IMDB summaries).

7.2 Analyze and interpret the resulting topic-word distributions, assigning a descriptive name to each discovered topic.

Exercise 8: Zero-Shot and Few-Shot Classification

8.1 Use a pre-trained Hugging Face model to perform zero-shot text classification on a dataset (e.g., classifying a tweet as "joy," "sadness," or "anger") without any explicit training data.

8.2 Implement a few-shot learning prompt template to adapt a large language model (LLM) to a new classification task with only 3-5 examples.

Exercise 9: Named Entity Recognition (NER) Error Analysis

9.1 Run a pre-trained NER model (e.g., spaCy's default model) on a domain-specific dataset (e.g., product reviews or clinical notes).

9.2 Manually analyze and document at least 10 instances where the model makes an error (e.g., misclassifying a product name as a person), proposing solutions (e.g., better training data or specialized dictionaries).

Exercise 10: Building a Simple Conversational Agent with Rule-Based Fallbacks

10.1 Develop a basic rule-based chatbot (e.g., using regular expressions or simple state machines) to handle generic greetings and simple FAQ requests.

10.2 Integrate this rule-based system as a fallback mechanism for a transformer-based Question-Answering (QA) model, ensuring the bot always has a response, even when the QA model is uncertain

| | | T | P | C |
|---|---|---|---|---|
| COURSE CODE: | **AI-304** | | | |
| COURSE TITLE: | **Deep Learning** | **1** | **3** | **2** |

To delve into advanced neural network architectures, including Convolutional Neural Networks (CNNs) for image analysis and Recurrent Neural Networks (RNNs) for sequence data, using frameworks like TensorFlow and Keras.

## COURSE OBJECTIVE:

At the end of the course the students are expected to be able to:

- Master optimization algorithms like Adam and SGD and regularization techniques such as Dropout and BatchNorm.
- Implement and understand modern Convolutional Neural Networks (CNNs) for computer vision tasks.
- Work with Recurrent Neural Networks (RNNs), LSTMs, and GRUs for sequence data like time-series and text.
- Build Generative Adversarial Networks (GANs) and Autoencoders.
- Apply advanced architectures, including Vision Transformers (ViTs) and multimodal models.
- Utilize Transfer Learning by adapting pre-trained models to new datasets.
- Implement professional MLOps practices, including model versioning and experiment tracking using tools like Weights & Biases

## COURSE DURATION:

| | | |
|---|---|---|
| Theory | 32 hours | one hour per week |
| Practical / Lab | 96 hours | one hour per week |

## PRACTICAL FEATURES:

- Architecture Implementation: Students implement key architectures (CNNs, RNNs, GANs) both from scratch and using high-level APIs.
- Experiment Tracking: All projects are logged with W&B, teaching professional MLOps practices from the start.

**ASSESSMENT METHODS:**

- Architecture Lab Notebooks (30%): A series of notebooks where students build and explain different network architectures.
- Transfer Learning Project (30%): A project where students must select a pre-trained model and adapt it to a new, complex image or text dataset.

**TOOLS AND TECHNOLOGIES:**

- Frameworks: TensorFlow 2.x / PyTorch (course can choose one or introduce both)
- Core Libraries: Keras, NumPy, OpenCV (for image pre-processing)
- MLOps: Weights & Biases, MLflow, TensorBoard
- Cloud GPUs: Google Colab Pro, AWS EC2 (p2/x2 instances), or Azure NVv4 series

**DATASETS:**

- CIFAR-10/100: For CNN and image classification projects.
- Dogs vs. Cats: A classic binary image classification challenge.

**REFERENCE BOOK:**

- "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville (The "Deep Learning Bible")
- "Dive into Deep Learning" by Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola (Interactive, code-first approach)

## COURSE OUTLINE

| Contents | Hours |
|---|---|
| 1. Neural Networks Deep Dive | 4+12 |
| ● Optimization (Adam, SGD), Regularization (Dropout, BatchNorm)<br>○ Key Tools/Concepts: TensorFlow/PyTorch | |
| 2. Convolutional Neural Networks | 4+12 |
| ● Conv layers, pooling, modern architectures (ResNet, EfficientNet)<br>○ Key Tools/Concepts: TensorFlow/PyTorch | |

3. Recurrent Neural Networks 4+12

- LSTMs, GRUs, Seq2Seq models with attention
    - Key Tools/Concepts: TensorFlow/PyTorch

4. Advanced Architectures 4+12

- Autoencoders, Generative Adversarial Networks (GANs)
    - Key Tools/Concepts: TensorFlow/PyTorch

5. Transformer Architectures 4+12

- Vision Transformers (ViTs), Multimodal Models
    - Key Tools/Concepts: Hugging Face transformers

6. Deep Learning for Tabular Data 6+16

- Introduction to architectures like TabNet, FT-Transformer
    - Key Tools/Concepts: PyTorch Tabular

7. MLOps for Deep Learning 6+16

- Model versioning, experiment tracking, deployment
    - Key Tools/Concepts: Weights & Biases, TensorFlow Serving

# LIST OF PRACTICAL EXERCISES

Exercise 1: Implement a modern CNN (like ResNet-50) for a custom image classification task using Transfer Learning.

Exercise 2: Train an LSTM model for time-series forecasting on stock price or sensor data.

Exercise 3: Build a Seq2Seq model with attention for machine translation on a small dataset.

Exercise 4: Create a simple GAN to generate novel images (e.g., of faces or fashions).

Exercise 5: Track a full model training lifecycle using Weights & Biases, including hyperparameter sweeps.

Exercise 6: Optimization and Initialization Comparison

6.1. Train a small, deep Feedforward Neural Network (FFNN) on the CIFAR-10 dataset.

6.2. Compare the impact of different weight initialization techniques (Xavier/Glorot vs. He) on the model's convergence speed and final accuracy, and document the findings.

Exercise 7: Implementing Regularization

7.1. Take a simple classification model and purposefully overfit it.

7.2. Implement Dropout layers and Batch Normalization (BatchNorm) layers, and observe how these techniques stabilize training, reduce overfitting, and improve generalization.

Exercise 8: Dimensionality Reduction with Autoencoders

8.1. Build a simple Autoencoder architecture (an encoder and a decoder).

8.2. Train the Autoencoder on a high-dimensional dataset (e.g., MNIST).

8.3. Use the encoded latent space for dimensionality reduction (e.g., reduce 784 features to 32) and verify the quality of the reconstruction.

Exercise 9: Attention Mechanism Implementation

9.1. Implement the core Self-Attention mechanism

9.2. from scratch using only NumPy or base TensorFlow/PyTorch tensor operations (without using the high-level Attention layer). * Visually demonstrate the dot-product attention scores for a short sequence of input vectors.

Exercise 10: Debugging and Visualization with TensorBoard

10.1. Integrate TensorBoard into a model training loop.

10.2. Use TensorBoard to monitor and visualize key aspects of the network during training, specifically tracking loss curves, layer weight histograms, and activation distributions to identify potential training issues like dead neurons.

| | | T | P | C |
|---|---|---|---|---|
| COURSE CODE: | **AI-305** | | | |
| COURSE TITLE: | **Generative AI (GenAI)** | **1** | **3** | **2** |

Generative AI refers to AI systems capable of creating new content such as text, images, audio, and video.It works by learning patterns from large datasets and generating outputs that resemble human-created content.

**COURSE OBJECTIVE:**

- Understand the architecture of modern generative models (Transformers, Diffusion).
- Learn how to generate original content (text, images) using GenAI tools and APIs.
- Apply GenAI techniques to practical real-world tasks and projects.
- Explore ethical considerations and responsible use of generative technologies.

**COURSE DURATION:**

| | | |
|---|---|---|
| Theory | 32 hours | one hour per week |
| Practical / Lab | 96 hours | one hour per week |

**ASSESSMENT:**

- Weekly: Model output evaluations (40%)
- Midterm: Ethics case study (20%)
- Final: Deployed GenAI app (40%)

**TOOLS:**

- APIs: OpenAI, Hugging Face
- Libraries: LangChain, Diffusers
- Platforms: RunwayML, ElevenLabs

**REFERENCE BOOKS AND RESOURCES**

**Prompt Engineering:**

- "The Art of Prompt Engineering" by Nathan Hunter

## COURSE OUTLINE

| Contents | | Hours |
|---|---|---|
| **1.** | **GenAI Fundamentals** | 4+12 |
| 1.1. | History of Generative AI | |
| 1.2. | Ethics & Responsible AI | |
| 1.3. | Basic model architectures | |
| **2.** | **Prompt Engineering** | 4+12 |
| 2.1. | Prompting techniques | |
| 2.2. | Best practices | |
| 2.3. | Few-shot & zero-shot prompting | |
| **3.** | **Text Generation** | 4+12 |
| 3.1. | GPT-based models | |
| 3.2. | Fine-tuning & customization | |
| **4.** | **Image Generation** | 4+12 |
| 4.1. | Stable Diffusion | |
| 4.2. | DALL·E | |
| 4.3. | Prompt design for images | |
| **5.** | **Audio Generation** | 4+12 |
| 5.1. | Text-to-speech (TTS) | |
| 5.2. | Music generation | |
| **6.** | **Video Generation** | 4+12 |
| 6.1. | Text-to-video pipelines | |
| 6.2. | Lip-sync & avatar generation | |
| **7.** | **Deployment** | 4+12 |
| 7.1. | API-based deployment | |
| 7.2. | UI development for GenAI apps | |
| **8.** | **Capstone Projects** | 4+12 |
| 8.1. | Building end-to-end GenAI applications | |
| 8.2. | Combining models and tools into real solutions | |

## LIST OF PRACTICAL EXERCISES

1. Compare outputs of different AI models (GPT-3 vs. Claude)
2. Write an ethics case study on deepfakes
3. Create a "persona prompt" for a historical figure chatbot
4. Solve logic puzzles using chain-of-thought prompting
5. Fine-tune a GPT model on custom poetry dataset
6. Build a Wikipedia-style article generator
7. Generate product mockups from text descriptions
8. Create "style transfer" images (e.g., Van Gogh selfie
9. Clone your voice with <11 characters of audio
10. Generate a jazz melody from text description
11. Make a talking avatar from text input
12. Create a 3-second product ad video
13. Build a Gradio UI for your text generator
14. Create a FastAPI endpoint for image generation
15. Capstone Projects:
    - Option A: AI content creation studio (text+image+audio)
    - Option B: Personalized learning tutor with generated content

| | | T | P | C |
|---|---|---|---|---|
| COURSE CODE: | **AI-306** | | | |
| COURSE TITLE: | **Introduction to Blockchain** | **1** | **3** | **2** |

To understand the fundamental principles of blockchain technology and smart contracts, and to explore its convergent potential with AI for creating secure, transparent, and decentralized intelligent systems.

## COURSE OBJECTIVE:

At the end of the course the students are expected to be able to:

- Understand the fundamentals of Distributed Ledgers, Cryptography, and Consensus Mechanisms (PoW, PoS).
- Explain the Ethereum Virtual Machine (EVM) and the role of Gas in transactions.
- Write, compile, and deploy Smart Contracts using Solidity.
- Interact with the blockchain using Web3 libraries (Web3.py/Ethers.js) to build decentralized applications (dApps).
- Design a system for using blockchain to establish data provenance and integrity for AI models.
- Understand the concepts of Federated Learning and its intersection with blockchain for privacy.
- Analyze the role of AI Oracles in decentralized finance (DeFi).
- Grasp the concepts of Tokenomics and Decentralized Autonomous Organizations (DAOs).

## COURSE DURATION:

| | | |
|---|---|---|
| Theory | 32 hours | one hour per week |
| Practical / Lab | 96 hours | one hour per week |

**PRACTICAL FEATURES:**

- Smart Contract Development: The core of the course is writing, testing, and deploying Solidity contracts.
- Testnet Deployment: All contracts are deployed on Ethereum testnets (Sepolia), providing a real-world, gas-aware development experience.

**ASSESSMENT METHODS:**

- Smart Contract Audits (30%): Students are given a vulnerable smart contract and must identify and fix the security flaws.
- dApp Development Project (40%): Build and demonstrate a functional decentralized application that interacts with a custom smart contract.

**TOOLS AND TECHNOLOGIES:**

- Smart Contracts: Solidity, Remix IDE, Hardhat/Foundry
- dApp Development: Web3.py or Ethers.js, React/Streamlit for frontend, MetaMask
- Blockchain: Ethereum Sepolia Testnet, Local Hardhat Network
- Storage: IPFS (for storing data hashes or model weights off-chain)
- APIs: Infura/Alchemy for node access

**DATASETS:**

- Cryptocurrency Price Data (e.g., from Binance API): For building analytical dApps.
- On-Chain Data (via The Graph): For querying transaction histories and smart contract events.

**REFERENCE BOOKS:**

- "Mastering Bitcoin: Programming the Open Blockchain" by Andreas M. Antonopoulos (For foundational crypto concepts)
- "Mastering Ethereum: Building Smart Contracts and dApps" by Andreas M. Antonopoulos and Gavin Wood

# COURSE OUTLINE

| Contents | Hours |
|---|---|
| 1. Blockchain Fundamentals | 4+12 |
| ● Distributed Ledgers, Cryptography, Consensus Mechanisms (PoW, PoS)<br>○ Key Tools/Concepts: -- | |
| 2. Ethereum & Smart Contracts | 4+12 |
| ● EVM, Gas, Writing and Deploying Smart Contracts<br>○ Key Tools/Concepts: Solidity, Remix IDE | |
| 3. Web3 & dApp Development | 4+12 |
| ● Interacting with the blockchain using Web3.py/Web3.js<br>○ Key Tools/Concepts: Web3.py, Metamask | |
| 4. Blockchain for Data Provenance | 4+12 |
| ● Using blockchain to track data lineage for AI models<br>○ Key Tools/Concepts: IPFS, Ethereum | |
| 5. Federated Learning & Blockchain | 4+12 |
| ● Decentralized model training while preserving data privacy<br>○ Key Tools/Concepts: PySyft (concept) | |
| 6. DeFi and AI Oracles | 6+16 |
| ● How AI models can act as oracles for decentralized finance<br>○ Key Tools/Concepts: Chainlink | |
| 7. Tokenomics & DAOs | 6+16 |
| ● Incentive structures and decentralized autonomous organizations<br>○ Key Tools/Concepts: -- | |

## LIST OF PRACTICAL EXERCISES

Exercise 1: Write, compile, and deploy a simple "Hello World" smart contract on a testnet (e.g., Sepolia).

Exercise 2: Build a simple dApp that allows a user to store and retrieve a string on the blockchain via a web frontend.

Exercise 3: Design a system where the hash of a training dataset is stored on-chain to prove its integrity for an AI model.

Exercise 4: Research and present a case study on a project combining AI and Blockchain (e.g., for decentralized data marketplaces).

Exercise 5: Write a whitepaper outline for a token designed to incentivize data labeling for an AI project.

Exercise 6: Smart Contract Security Audit and Fix

6.1. Examine a provided smart contract (e.g., an ERC-20 token or a simple auction contract) that contains a known security vulnerability (e.g., a reentrancy attack risk or an integer overflow).

6.2. Identify the vulnerability, write a test case to exploit it, and then implement the security fix (e.g., using the Checks-Effects-Interactions pattern or OpenZeppelin's secure math libraries).

Exercise 7: Implementing Token Standards

7.1. Use the OpenZeppelin contracts library as a foundation to create a standard, functioning ERC-20 token on a local development network (Hardhat/Foundry).

7.2. Test the token's basic functionalities, such as minting, transferring, and checking balances.

Exercise 8: Interacting with IPFS for Decentralized Storage

8.1. Take a large, sensitive document (simulating an AI model weight file or a proprietary dataset) and calculate its hash (fingerprint) locally.

8.2. Upload the original file to IPFS (InterPlanetary File System).

8.3. Write and deploy a simple Solidity contract that stores the IPFS hash (the content identifier or CID) on the blockchain, creating an immutable link to the data's location.

Exercise 9: Querying On-Chain Data with The Graph

9.1. Select a simple, existing contract deployed on a public testnet (e.g., a decentralized exchange or a token contract).

9.2. Use The Graph's decentralized indexing protocol to create a basic subgraph that tracks a specific event (e.g., Transfer events for the token).

9.3. Write a GraphQL query to retrieve the last 10 transfers, demonstrating how to extract and analyze historical on-chain data.

Exercise 10: Building a Basic Oracle System

10.1. Design a simple off-chain script (in Python) that fetches a piece of real-world data (e.g., the current USD price of ETH) from an external API.

10.2. Write a Solidity contract that can receive this data.

10.3. Simulate an oracle update where the off-chain script securely sends the latest price data to the smart contract, enabling the contract to use external information.