UNIVERSITY OF SARGODHA
OFFICE OF THE REGISTRAR
(ACAD BRANCH)

NOTIFICATION

On the recommendations of Academic Council made in its 24th (1/2025) meeting held on 26.08.2025, the Syndicate in its 72nd (4/2025) meeting held on 12.09.2025 has approved the revised curricula of following programs for implementation w.e.f. **Fall 2025**.

I.	Associate Degree in Mathematics	(Annex-'**A**')
II.	BS in Mathematics	(Annex-'**B**')
III.	BS in Mathematics (5th Semester Intake)	(Annex-'**C**')

(WAQAR AHMAD)
Additional Registrar (General)

No. SU/Acad/25/ 1184

Dated: 03.11.2025

Distribution:

- Chairman, Department of Mathematics
- Controller of Examinations
- Director Academics

C.C:

- Dean Faculty of Sciences
- Director, QEC
- Additional Registrar (A & R) *{With the request to forward the notification alongwith curriculum to all Principals of affiliated colleges concerned}*
- Secretary to the Vice-Chancellor
- PA to Registrar
- Notification File

SCHEME OF STUDIES

BS Mathematics

(w.e.f. FALL-2025)

DEPARTMENT OF MATHEMATICS
UNIVERSITY OF SARGODHA
SARGODHA

1. **Title of Degree Program:** BS Mathematics
2. **Program Learning Objectives:**

Graduates will be able to

- understand the mathematics theoretically and then visualized by computer programming.
- utilize the knowledge for professional skill development.
- demonstrate good communication skills in professional and academic presentations.
- upgrade knowledge and skills through professional experience and higher studies.

3. **Program Structure:**

Minimum Credit Hours	143
General Education	35 credit hours (14 courses)
Discipline Related Courses / Major	81 credit hours (27 courses)
Interdisciplinary / Allied Courses	21 credit hours (7 courses)
Internship	3 credit hours
Capstone	3 credit hours
Program Duration	Minimum: 4 years (8 regular semesters) Maximum: 6 years (12 regular semesters) The maximum limit is further extendable in accordance with HEC semester rules.
Admission Requirements:	**Eligibility:** Intermediate/Part-I or equivalent with Mathematics (at least 45% marks in Intermediate & 50% marks in Mathematics).
Semester Duration	16-18 weeks for regular semesters (1-2 weeks for examination)
Course Load (per semester)	15-18 credit hours for regular semesters
3 Credit Hours (Theory)	2 classes (1.5 hours each) / 3 classes (1 hour each) per week throughout the semester.
1 Credit Hours (Lab / Field Work)	1 credit hour in laboratory or practical work / project requires lab contact of 3 hours per week throughout the semester.

4. **General Education (Gen Ed) Requirements:(Mandatory/Core Curses):**
(The minimum requirement for Gen Ed is 35 credits hours)

Sr. No.	Course Code	Course Title	Credit Hours	Prerequisite
1.	URCG-5129/ URCG-5131	Understanding of Holy Quran-I*/Ethics-I**	1(0-1)	Nil
2.	URCG-5130/ URCG-5132	Understanding of Holy Quran-II*//Ethics-II**	1(0-1)	Nil
3.	URCG-5112 PICS-5110 ARAB- 5109	Fables, Wisdom Literature, and Epic/ Chinese Language / Arabic Language	2(2-0)	Nil
4.	URCG-5114	Basic Science	3(2-1)	Nil
5.	URCG-5116 ECON-5118 EDUC- 5110 INTR- 5101	Science of Society-I / Mathematical Economics / Teaching Mathematics / Introduction to International Relations	2(2-0)	Nil
6.	URCG-5118	Functional English	3(3-0)	Nil

7.	URCG-5119	Expository Writing	3(3-0)	Nil
8.	URCG-5120	Exploring Quantitative Skills	3(3-0)	Nil
9.	URCG-5121	Tools for Quantitative Reasoning	3(3-0)	Nil
10.	URCG-5105 URCG-5126	Islamic Studies (OR) Religious Education/Ethics	2(2-0)	Nil
11.	URCG-5122	Ideology and Constitution of Pakistan	2(2-0)	Nil
12.	URCG-5123	Applications of Information and Communication Technologies (ICT)	3(2-1)	Nil
13.	URCG-5124	Entrepreneurship	2(2-0)	Nil
14.	URCG-5125	Civics and Community Engagement	2(2-0)	Nil
15.	URCG-5127	Seerat of the Holy Prophet (SAW)*	1(1-0)	Nil
16.	URCG-5128	Pakistan Study	2(2-0)	Nil
		Total Credit Hours	35	

5. **Single Major Courses:**

Sr. No.	Course Code	Course Title	Credit Hours	Prerequisite
1.	MATH-5101	Calculus-I	3(3-0)	Nil
2.	MATH-5102	Calculus-II	3(3-0)	MATH-5101
3.	MATH-5103	Discrete Mathematics	3(3-0)	Nil
4.	MATH-5104	Calculus-III	3(3-0)	MATH-5102
5.	MATH-5105	Abstract Algebra	3(3-0)	Nil
6.	MATH-5106	Vector and Tensor Analysis	3(3-0)	Nil
7.	MATH-5107	Linear Algebra	3(3-0)	Nil
8.	MATH-5108	Fundamental of Mechanics	3(3-0)	Nil
9.	MATH-5109	Number Theory	3(3-0)	Nil
10.	MATH-5110	Ordinary Differential Equations	3(3-0)	Nil
11.	MATH-6101	Real Analysis-I	3(3-0)	Nil
12.	MATH-6102	Topology	3(3-0)	Nil
13.	MATH-6103	Partial Differential Equations	3(3-0)	Nil
14.	MATH-6104	Numerical Analysis-I	3(3-0)	Nil
15.	MATH-6105	Real Analysis-II	3(3-0)	MATH-6101
16.	MATH-6106	Complex Analysis	3(3-0)	Nil
17.	MATH-6107	Numerical Analysis-II	3(3-0)	MATH-6104
18.	MATH-6111	Differential Geometry	3(3-0)	Nil
19.	MATH-6114	Integral Equations	3(3-0)	Nil
20.	MATH-61xx	Elective-I***	3(3-0)	Nil
21.	MATH-61xx	Elective-II***	3(3-0)	Nil
22.	MATH-61xx	Elective-III***	3(3-0)	Nil
23.	MATH-61xx	Elective-IV***	3(3-0)	Nil
24.	MATH-61xx	Elective-V***	3(3-0)	Nil
25.	MATH-61xx	Elective-VI***	3(3-0)	Nil
26.	MATH-61xx	Elective-VII***	3(3-0)	Nil
27.	MATH-61xx	Elective-VIII***	3(3-0)	Nil
Major Courses Credit Hours Total			**81**	

6. **Interdisciplinary/Allied courses: 21 credit hours:**
(Interdisciplinary/Allied courses will be offered after 4th semester)

1.	CMPC-5201	Programming Fundamentals	3(2-1)	Nil
2.	STAT-5111	Statistics and Probability Theory	3(3-0)	Nil
3.	CSIT-6101	Programming Languages for Mathematicians	3(2-1)	Nil

4.	PHYS-6130	Introduction to Mechanics	3(2-1)	Nil
5.	AIDC-4102	Machine Learning	3(2-1)	Nil
6.	EDUC-6129	Scientific Writing & Research Methods	3(3-0)	Nil
7.	PHYS-6131	Introduction to Classical Mechanics	3(3-0)	Nil
Interdisciplinary Courses Credit Hours Total			**21**	

7. **Field experience/internship: 03 credit hours:**
(Lasting 6-8 weeks and ideally scheduled during summer breaks after 6th semester)

1.	**MATH-6112**	**Field experience/Internship**	**3(0-3)**	Nil

8. **Capstone project: 03 credit hours:**
(This project, after the sixth semester, requires faculty supervision and evaluation following department guidelines)

1.	**MATH-6113**	**Capstone project**	**3(0-3)**	Nil

Scheme of Studies
BS Mathematics

Semester-I

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
Major-1	MATH-5101	Calculus-I	3(3-0)	Nil
Indn-1	CMPC-5201	Programming Fundamentals	3(2-1)	Nil
GE-1	URCG-5120	Exploring Quantitative Skills	3(3-0)	Nil
GE-2	URCG-5114	Basic Science	3(2-1)	Nil
GE-3	URCG-5118	Functional English	3(3-0)	Nil
GE-4	URCG-5123	Applications of Information and Communication Technologies (ICT)	3(2-1)	Nil

Semester Total Credit Hours: **18**

Semester-II

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
Major-2	MATH-5102	Calculus-II	3(3-0)	MATH-5101
Major-3	MATH-5103	Discrete Mathematics	3(3-0)	Nil
GE-5	URCG-5121	Tools for Quantitative Reasoning	3(3-0)	Nil
GE-6	URCG-5119	Expository Writing	3(3-0)	Nil
GE-7	URCG-5128	Pakistan Studies	2(2-0)	Nil
GE-8	URCG-5112 PICS-5110 ARAB- 5109	Fables, Wisdom Literature, and Epic/ Chinese Language / Arabic Language	2(2-0)	Nil
GE-9	URCG-5127	Seerat of the Holy Prophet (SAW)*	1(1-0)	Nil
GE-10	URCG-5129/ URCG-5131	Understanding of Holy Quran-I*/Ethics-I**	1(0-1)	Nil

Semester Total Credit Hours: **18**

Semester-III

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
Major-4	MATH-5104	Calculus-III	3(3-0)	MATH-5102
Major-5	MATH-5105	Abstract Algebra	3(3-0)	Nil
Major-6	MATH-5106	Vector and Tensor Analysis	3(3-0)	Nil
Indn-2	STAT-5111	Statistics and Probability Theory	3(3-0)	Nil
GE-11	URCG-5122	Ideology and Constitution of Pakistan	2(2-0)	Nil
GE-12	URCG-5105 URCG-5126	Islamic Studies (OR) Religious Education/Ethics	2(2-0)	Nil
GE-13	URCG-5116 ECON-5118 EDUC- 5110 INTR- 5101	Science of Society-I / Mathematical Economics / Teaching Mathematics / Introduction to International Relations	2(2-0)	Nil

Semester Total Credit Hours: **18**

Semester-IV

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
Major-7	MATH-5107	Linear Algebra	3(3-0)	Nil
Major-8	MATH-5108	Fundamentals of Mechanics	3(3-0)	Nil
Major-9	MATH-5109	Number Theory	3(3-0)	Nil
Major-10	MATH-5110	Ordinary Differential Equations	3(3-0)	Nil
GE-14	URCG-5125	Civics and Community Engagement	2(2-0)	Nil
GE-15	URCG-5124	Entrepreneurship	2(2-0)	Nil
GE-16	URCG-5130/ URCG-5132	Understanding of Holy Quran-II*//Ethics-II**	1(0-1)	Nil

Semester Total Credit Hours: **17**

Semester-V

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
Major-11	MATH-6101	Real Analysis-I	3(3-0)	Nil
Major-12	MATH-6102	Topology	3(3-0)	Nil
Major-13	MATH-6103	Partial Differential Equations	3(3-0)	Nil
Major-14	MATH-6104	Numerical Analysis-I	3(3-0)	Nil
Indn-3	CSIT-6101	Programming Languages for Mathematicians	3(2-1)	Nil
Indn-4	PHYS-6130	Introduction to Mechanics	3(3-0)	Nil

Semester Total Credit Hours: **18**

Semester-VI

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
Major-15	MATH-6105	Real Analysis-II	3(3-0)	MATH-6101
Major-16	MATH-6106	Complex Analysis	3(3-0)	Nil
Major-17	MATH-6107	Numerical Analaysis-II	3(3-0)	MATH-6104
Major-18	MATH-6108	Mathematical Methods***	3(3-0)	Nil
Indn-5	AIDC-4102	Machine Learning	3(3-0)	Nil
Indn-6	PHYS-6131	Introduction to Classical Mechanics	3(3-0)	Nil

Semester Total Credit Hours: **18**

Semester-VII

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
Major-19	MATH-6111	Differential Geometry	3(3-0)	Nil
Major-20	MATH-61xx	Elective-II***	3(3-0)	Nil
Major-21	MATH-61xx	Elective-III***	3(3-0)	Nil
Major-22	MATH-61xx	Elective-IV***	3(3-0)	Nil
Indn-07	EDUC-6129	Scientific Writing & Research Methods	3(3-0)	Nil
Compulsory	MATH-6112	Field experience/Internship	3(0-3)	Nil

Semester Total Credit Hours: **18**

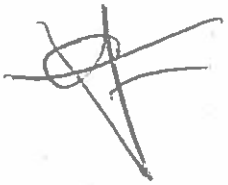
Semester-VIII

Category	Course Code	Course Title	Credit Hours	Pre-Requisite
Major-23	MATH-6114	Integral Equations	3(3-0)	Nil
Major-24	MATH-6115	Functional Analysis***	3(3-0)	Nil
Major-25	MATH-61xx	Elective-VI***	3(3-0)	Nil
Major-26	MATH-61xx	Elective-VII***	3(3-0)	Nil
Major-27	MATH-61xx	Elective-VIII***	3(3-0)	Nil
Compulsory	MATH-6113	Capstone Project	3(0-3)	Nil

Semester Total Credit Hours: **18**

Degree Program Total: 143

*These courses for Muslim students only.
**These courses for non-Muslim students only.
*** These courses are elective & can be selected from the list of elective courses.
Note: These courses will be offered by the department from the list of concentration elective courses as per availability of the resources.



List of Elective Courses

Course Code	Course Title	Credit Hours	Pre-Requisite
MATH-6108	Mathematical Methods	3(3-0)	Nil
MATH-6115	Functional Analysis	3(3-0)	Nil
MATH-6116	Special Functions	3(3-0)	Nil
MATH-6117	Graph Theory	3(3-0)	Nil
MATH-6118	Advanced Group Theory-I	3(3-0)	Nil
MATH-6119	Advanced Group Theory-II	3(3-0)	MATH-6118
MATH-6120	Rings & Modules	3(3-0)	Nil
MATH-6121	Field Theory	3(3-0)	Nil
MATH-6122	Fluid Mechanics-I	3(3-0)	Nil
MATH-6123	Fluid Mechanics-II	3(3-0)	MATH-6122
MATH-6124	Operations Research-I	3(3-0)	Nil
MATH-6125	Operations Research-II	3(3-0)	MATH-6124
MATH-6126	Analytical Dynamics	3(3-0)	Nil
MATH-6127	Special Relativity	3(3-0)	Nil
MATH-6128	Heat Transfer	3(3-0)	Nil
MATH-6129	Measure Theory	3(3-0)	Nil
MATH-6130	Theory of Splines-I	3(3-0)	Nil
MATH-6131	Theory of Splines-II	3(3-0)	MATH-6130
MATH-6132	Methods of Optimization-I	3(3-0)	Nil
MATH-6133	Methods of Optimization-II	3(3-0)	MATH-6132
MATH-6134	Bio-Mathematics	3(3-0)	Nil

List of General Education (Gen Ed) (Mandatory/Core) Curses

Ethics-I

URCG-5131

1 (0-1)

1-Course Description

The Ethics-I course is designed to provide students with a comprehensive understanding of ethical principles, practices, and theories in various societal contexts. Throughout this degree program, students will explore the complexities of ethical theories of semitic and non-semitic religions along with decision-making and develop critical thinking skills to navigate moral dilemmas. This course will also enable the students to interact with others religious identities with humanistic, inclusive and holistic approach

2- Learning Objectives

This course aims to:

1. Introduce students to the fundamental concepts, scope, and importance of ethics.
2. Explore the relationship between law, morality, and social values.
3. Develop a clear understanding of virtuous and immoral ethics and their impact on individual and collective life.
4. Study the role of major religious figures in the moral development of human society and enable students to apply ethical principles for personal development, conflict resolution, and social harmony.

3- Learning Outcomes

By the end of the course, students will be able to:

1. Students will be able to identify and analyze major ethical theories, values, and their scope in social and individual life.
2. Differentiate between law and ethics, and analyze their interrelationship.
3. Identify types of virtuous and immoral ethics and assess their social impacts.
4. Examine the ethical teachings of major religions and their relevance in contemporary society.
5. Apply ethical principles to address modern challenges in personal and professional life.

4-Course Structure

1. Interactive lectures, Group discussions and debates
2. Reflection papers and presentations
3. Assignments and Quiz

Course Contents

Unit 1: Introduction and Fundamentals of Ethics

1. Literal and terminological definition of ethics
2. Literal and terminological definition of values
3. Relationship between law and ethics
4. Need, importance, and scope of ethics

Unit 2: Types of Ethics and Their Impact on Society

- Virtuous ethics: concept, types, benefits, and outcomes
- Immoral ethics: concept, types, and harms
- Role of ethics in social refinement and establishment of peace

Unit 3: Virtuous Ethics (Akhlaq-e-Hasanah)

- Concept, need, and importance of virtuous ethics
- Scope of virtuous ethics in the light of religions
- Major virtues in revealed and non-revealed religions
- Impact of virtuous ethics on individual and collective life

Unit 4: Immoral Ethics (Akhlaq-e-Razilah)

- Concept of immoral ethics
- Social problems caused by immoral ethics
- Practical consequences of immoral ethics
- Major vices in revealed and non-revealed religions

Unit 5: Role of World Religious Figures in Moral Development

- Prophet Moses (AS): introduction, miracles, and role in moral refinement
- Prophet Jesus (AS): introduction, miracles, and role in moral refinement
- Prophet Muhammad (ﷺ): introduction, miracles, and role in moral refinement

Textbook

1. Izutsu, T. (2002). *Ethico-Religious Concepts in the Qur'an*. McGill-Queen's University Press.

Suggested Readings

1. Gert, B. (2005). *Morality: Its Nature and Justification*. Oxford University Press.
2. MacIntyre, A. (2007). *After Virtue: A Study in Moral Theory*. University of Notre Dame Press.
3. Al-Ghazali, Abu Hamid (2001). *The Alchemy of Happiness*. Islamic Texts Society.
4. Nasr, S. H. (1994). *The Heart of Islam: Enduring Values for Humanity*. Harper One.
5. Beauchamp, T. L., & Childress, J. F. (2019). *Principles of Biomedical Ethics*. Oxford University Press.
6. Hasan, Z. (2010). *Ethics in Islam: Key Concepts and Contemporary Challenges*. Islamic Research Institute.

Ethics-II

URCG-5132

1 (0-1)

1-Course Description

The course *Ethics-II* is designed to provide students with a deeper understanding of ethical principles and practices from both Semitic and non-Semitic religions, as well as their application in professional and social contexts. Students will engage with Jewish, Christian, Islamic, Hindu, Buddhist, Sikh, Confucian, and Jain ethical traditions. The course emphasizes moral reasoning, decision-making, tolerance, and peacebuilding. It aims to cultivate an inclusive, humanistic, and holistic approach towards ethical living and interfaith engagement.

2- Learning Objectives

The course objectives are to:

1. Understand the fundamental principles and theories of ethics.
2. Introduce the ethical and moral teachings of Judaism, Christianity, Islam, and Hinduism.
3. Explore the ethical teachings of non-Semitic religions such as Buddhism, Sikhism, Confucianism, and Jainism.
4. Develop critical thinking skills to evaluate ethical arguments and theories.
5. Promote ethical leadership and interfaith harmony.

3- Learning Outcomes

By the end of this course, students will be able to:

1. Identify and analyze major ethical theories and teachings from world religions.
2. Understand the role of religions in improving moral values and social behavior.
3. Demonstrate ethical decision-making in various personal and professional contexts.
4. Recognize the impact of ethical decisions on individuals, communities, and society.
5. Apply skills of ethical leadership, including communication, conflict resolution, and inclusive engagement.

4-Course Structure

1. Interactive lectures, Group discussions and debates
2. Reflection papers and presentations
3. Assignments and Quiz

~~Course Title: Ethics-II (For Non-Muslim Students) Course Code: URGC-5130~~ X

Course Contents

Unit 1: Ethical Teachings of Semitic Religions

- Judaism and its ethical teachings
- Christianity and its ethical teachings
- Islam and its ethical teachings

Unit 2: Ethical Teachings of Non-Semitic Religions

- Hinduism and its ethical teachings
- Sikhism and Buddhism: ethical values and practices
- Confucian and Jain ethical traditions

Unit 3: Professional Ethics

- Ethics for students and teachers
- Ethics in doctor–patient relationships
- Ethics in trader–customer interactions

Unit 4: Concept and Significance of Tolerance

- Definition, need, and importance of tolerance
- Teachings of Semitic religions on tolerance and their contemporary relevance
- Teachings of non-Semitic religions on tolerance and their contemporary relevance

Unit 5: Foundational Values and Ethics for Peacebuilding in Society

- Respect for sacred scriptures, personalities, places of worship, and religious symbols
- Promotion of tolerance and broadmindedness
- Encouragement of dialogue and harmony
- Benevolence towards humanity
- Establishment of justice and fairness
- Patience, forbearance, and forgiveness

Textbook

- Kidder, R. M. (2009). *How Good People Make Tough Choices: Resolving the Dilemmas of Ethical Living*. Harper.

Suggested Readings

1. Barash, D. P., & Webel, C. P. (2014). *Peace and Conflict Studies*. Sage.
2. Smart, N. (1998). *The World's Religions*. Cambridge University Press.
3. Nasr, S. H. (2003). *The Heart of Islam: Enduring Values for Humanity*. HarperOne.
4. Sharma, A. (2006). *Hindu Ethics: Purity, Abortion, and Euthanasia*. SUNY Press.
5. Harvey, P. (2000). *An Introduction to Buddhist Ethics: Foundations, Values and Issues*. Cambridge University Press.
6. Coward, H., & Perkinson, J. (2013). *A Cross-Cultural Dialogue on Ethical Leadership*. Wilfrid Laurier University Press.
7. Confucius. (1998). *The Analects*. Oxford University Press.

Annex-A

URCG-5129

Model Course Outline
for the Course Understanding of Quran – I

Course Title: Understanding of Quran – I
Course Book: Muallim ul Quran (Volume 1, 2 & 3) by Dr Ubaid ur Rahman
Credit Hours: 1 (0-1)
Contact Hours: 3 per week
Weeks: 15-16 (45-48 hours)

Course Learning Outcomes:

By the end of this course, students will be able to:

1. Develop the ability to understand basic words of the Quran, phrases and sentences that do not contain verbs (unit 1 to 5 of Muallim ul Quran Book) and then sentences having present tense (first half of unit 6 of Muallim ul Quran Book).
2. Acquire a strong foundation for understanding long verses of the Quran with clarity.
3. Comprehend Quranic vocabulary, particles (operative & non operative particles) , compounds (Adjective & Possessive compound), pronouns (singular & plural) and types of plural through hundreds of Quranic sentences.
4. Recognize and understand different styles of Quranic sentences, including nominal sentence, emphatic sentence, double emphatic sentence, negative sentence, interrogative sentence, oath –based sentences.
5. Strengthen understanding of fundamental Quranic linguistic styles, expressions and idioms.
6. Understand at least 30 to 40 % of each page of the holy Quran.

Provision of material, content and books:

- **Paper book:** All volumes are available in printed book form.
- **Tutorial videos:** Teaching video of each lesson available on YouTube.
- **Confirmation Videos:** A complete series of confirmation videos of all lessons is available in which the student can confirm his answers.
- **A flipbook:** A flipbook edition is also accessible.
- **Helping material:** Helping material for the teachers like quizzes, question papers and images is available on website.

Course Outline:

Weeks	Lectures (1.5 hrs)	Units	Lessons	Assignments/Home Task	Linguistic Rules
1.	1.	1	1-6	Writing the meaning of Quranic words Lesson 1-8	Proper Noun Masculine & Feminine
	2.	1	9-14	Writing the meaning of Quranic words 9-14	Two kinds of plural Concept of (و) "And" Common Noun
2.	1.	1	15-17	Writing the meaning of Quranic words, phrases & translation of Sentences 15-17	Demonstrative Noun (This & That for Masculine (هذا- هذه) Demonstrative Noun (This & That for Feminine) (ذلك- تلك)
	2.	1	18-19 & Revision (Unit 1)	Writing the meaning of Quranic words , phrases & translation of Sentences 17-19 Quiz	Laam for emphasis (الام التاكيد) Superlative Degree like اكبر Revision of all Quranic Sentences
3.	1.	Unit 2	1-3	Writing the meaning of Quranic words, phrases & translation of Sentences 1-3	Emphatic Particle ان Preposition "For" (اللام) Preposition (في)
	2.	2	4-6	Writing the meaning of Quranic words, phrases & translation of Sentences 4-6	Preposition (على- من- إلى)
4.	1.	2	7- 9	Writing the meaning of Quranic words & translation of Sentences 7-9	Preposition (الباء) Absolute Negation Particle Exceptive Particle (لا النافية (للجنس)(ما النافية) (إلا)
	2.	2	10-13 & Revision (Unit 2)	Writing the meaning of Quranic words, phrases & translation of Sentences 10-13 Quiz	Subordinating Conjunction(أن), Was (كان), Vocative Particle(حرف النداء)

5.	1.	Unit 3	1-2	Writing the meaning of Quranic phrases 1-2	Quranic Adjective Compounds (صفة وموصوف)
	2.	3	3-5	Writing the meaning of Quranic phrases & translation of sentences 3-5	Quranic Possessive Construction (مضاف ومضاف إليه)
6.	1.	3	6 -7	Writing the meaning of Quranic phrase translation of sentences 6-7	Quranic Possessive Construction (مضاف ومضاف إليه)
	2.	3	8-10 & Revision (Unit 3)	Writing the meaning of Quranic phrase & translation of sentences 8-10 Quiz	Active Participle (اسم الفاعل), Passive Participle (اسم المفعول), Dual (مثنى)
7.	1.	Unit 4	1-2	Writing the meaning of Quranic phrase.& translation of sentences 1-2	Personal Pronoun He(هو المنفصل) Possessive Pronoun His ـه المتصل)
	2.	4	3-4	Writing the meaning of Quranic phrase & translation of sentences 3 -4	Possessive Pronoun with prepositions like في بيته Pronoun "His" with prepositions like له، منه، فيه
8.	1.	4	5-8	Writing the meaning of Quranic sentences 5-8	Personal Pronoun You(انت المنفصل) Possessive Pronoun Your ك المتصل) Possessive Pronoun with prepositions like في بيتك Pronoun "your" with prepositions like لك، منك، فيك
	2.	Mid-Term			

9.	1.	4	9-12	Writing the meaning of Quranic phrases & sentences 9-12	Personal Pronoun She(هي المنفصل) Possessive Pronoun Her ها المتصل) Possessive Pronoun with prepositions like لها في بيتها Pronoun "Her" with prepositions like لها،
	2.	4	13-16	Writing the meaning of Quranic phrases & sentences 13-16	Personal Pronoun I (أنا المنفصل) Possessive Pronoun Her ي المتصل) Possessive Pronoun with prepositions like في بيتيPronoun "My" with prepositions like لي
10.	1	4	17 & Revision Unit 4	Revision of all Quranic sentences of Unit 4 Quiz	Adverb (حال)
	2.	Unit 5	1-2	Writing the meaning of Quranic phrases & sentences 1-2	Masculine Plural جمع المذكر السالم و جمع المذكر السالم المسبوق بحرف الجر
11.	1.	5	3-4	Writing the meaning of Quranic phrases & sentences 3-4	Possessive Construction with Plurals جمع المذكر السالم المسبوق بالإضافة
	2.	5	5-6	Writing the meaning of Quranic phrases, sentences & verses 5-6	Personal Pronoun They (هم المنفصل) Possessive Pronoun Their هم المتصل)
12.	1.	5	7-8	Writing the meaning of Quranic phrases, sentences & verses 7-8	Possessive Pronoun with prepositions like في بيتهمPronoun "Their" with prepositions like لهم
	2.	5	9-11	Writing the meaning of Quranic phrases, sentences & verses 9-11	Personal Pronoun You (أنتم المنفصل) Possessive Pronoun Your كم المتصل) Possessive Pronoun with prepositions

					like في بيتكم
13.	1.	5	12-14	Writing the meaning of Quranic phrases & sentences & verses 12-14	Pronoun "Your" with prepositions like لكم Personal Pronoun We (نحن المنفصل) Possessive Pronoun Our نا المتصل)
	2.	5	15-16	Writing the meaning of Quranic sentences & verses 15-16	Possessive Pronoun with prepositions like في بيتنا Pronoun "Our" with prepositions like لنا
14.	1.	5	17-18	Writing the meaning of Quranic sentences & Verses 17-18	Demonstrative Pronoun These, Those (هؤلاء- أولئك)
	2.	5	19-23	Writing the meaning of Quranic sentences & Verses 19-23	(ما / إلا، إن / إلا، إنما، ليس، ما ، أم، أن، بل، كان) (ألا، اليس، اليوم، يومئذ، سبحان، مابينهما، قل، إذن، بئس، نعم، كلا، ما أدراك، حسب، أعلم به، مصير، مرجع، دينا(تمييز)
15.	1.	5	Revision Unit 5	Quiz	
	2.	5	1-3 (till Page 16)	Writing the meaning of Quranic Verbs &Translation of Quranic Sentences & Verses (1-3)	Introduction of Present Tense(فعل مضارع) & Verbal Sentence (جملة فعلية) Present Tense الفعل المضارع صيغة المفرد يعلم
16.	1.	6	3 (From Page 17) & 4 -5	Translation of Quranic Sentences & Verses 3-5	Present Tense الفعل المضارع صيغة المفرد يعلم
	2.	6	6	Translation of Quranic Sentences & Verses	Present Tense الفعل المضارع صيغة الجمع يعلمون

Annex- B

URCG-5130

Model Course Outline
for the Course Understanding of Quran – II

Course Title: Understanding of Quran – II
Course Book: Muallim ul Quran (Volume 3, 4 & 5) by Dr Ubaid ur Rahman
Credit Hours: 1 (0-1)
Contact Hours: 3 per week
Weeks: 15-16 (45-48 hours)

Course Learning Outcomes:

By the end of this course, students will be able to:

1. Directly comprehend hundreds of Quranic sentences & verses.
2. Understand at least 80 to 85 % of each page of the holy Quran.
3. Understand common verses across different Quranic topics.
4. Achieve proficiency in the basic and advance linguistic aspects of the Arabic language.
5. Understand the difference between Quranic verbs in various forms, such as present, past and imperative.
6. Develop the ability to understand long verses of the holy Quran independently and then comprehend their interpretation.

Provision of material, content and books:

- **Paper book:** All volumes are available in printed book form.
- **Tutorial videos:** Teaching video of each lesson available on YouTube.
- **Confirmation Videos:** A complete series of confirmation videos of all lessons is available in which the student can confirm his answers.
- **A flipbook:** A flipbook edition is also accessible.
- **Helping material:** Helping material for the teachers like quizzes, question papers and images is available on website.

Course Outline:

Weeks	Lectures	Units	Lessons	Assignments/Home Task	
1.	1.	6	6	Understanding & Translation of Verses	Present Tense صيغة جمع مذكر غائب مثل يعبدون
	2.	6	7-8	Understanding & Translation of Verses	Present Tense صيغة جمع مذكر غائب مثل يعبدون
2.	1.	6	9-10	Understanding & Translation of Verses	Present Tense صيغة مفرد مذكر مخاطب (تعبد) وجمع مذكر مخاطب (تعبدون)
	2.	6	11-12	Understanding & Translation of Verses	Present Tense صيغة جمع مذكر مخاطب (تعبدون)

					صيغة المتكلم (أعبد)
3.	1.	6	13	Understanding & Translation of Verses	Present Tense صيغة جمع المتكلم (نعبد)
	2.	6	14-15	Understanding & Translation of Verses	Negative Imperative صيغة المفرد وصيغة الجمع , لا تعبد، لا تعبدوا
4.	1.	6	16-17	Understanding & Translation of Verses	Conditional Sentences & masdar mawal (مصدر موول)
	2.	6	18-19	Understanding & Translation of Verses	Laam uttaleel (لام التعليل) & Laam ul jhood(لام الجحود)
5.	1.	6	20-21	Understanding & Translation of Verses	Present with object pronouns & Passive Voice
	2.	6	Revision (Unit 6)	Quiz	
6.	1.	Unit 7	1 (sec 1-3)	Understanding & Translation of Verses	Past Tense صيغة المفرد الغائب
	2.	6	1 (Sec 4-5)	Understanding & Translation of Verses	Past Tense صيغة المفرد للغائب
7.	1.	6	1 (Sec 5-6)	Understanding & Translation of Verses	Past Tense صيغة المفرد للغائب
	2.	6	1 (Sec 7-9)	Understanding & Translation of Verses	Past Tense صيغة المفرد للغائب
8.	1.	7	Revision	Understanding & Translation of Verses QUIZ	Past Tense صيغة المفرد للغائب
	2.	MID TERM			
9.	1.	7	2 (sec 1-2)	Understanding & Translation of Verses	Past Tense صيغة الجمع للغائب عبدوا
	2.	7	2 (sec 3)	Understanding & Translation of Verses	Past Tense صيغة الجمع للغائب عبدوا
10.	1.	7	2 (sec 4-5)	Understanding & Translation of Verses	Past Tense صيغة الجمع للغائب عبدوا
	2.	7	2 (sec 6-7)	Understanding & Translation of Verses	Past Tense صيغة الجمع للغائب عبدوا
11.	1.	7	3 (sec 1-2)	Understanding & Translation of Verses	Past Tense صيغة الجمع للمتكلم عبدنا

	2.	7	3 (sec 2-3)	Understanding & Translation of Verses	Past Tense صيغة الجمع للمتكلم عبدنا
12.	1.	7	3 (sec 3-4)	Understanding & Translation of Verses	Past Tense صيغة الجمع للمتكلم عبدنا
	2.	7	3 (sec 4-5)	Understanding & Translation of Verses	Past Tense صيغة الجمع للمتكلم عبدنا
13.	1.	7	4 (sec 1-2-3)	Understanding & Translation of Verses	Past Tense صيغة الجمع للمخاطب عبدتم
	2.	7	4 (sec 4-5)	Understanding & Translation of Verses	Past Tense صيغة الجمع للمخاطب عبدتم
14.	1.	7	5-6	Understanding & Translation of Verses Quiz	Past Tense صيغة المتكلم والمخاطب عبدتُ ، عبدتَ
	2.	7	7	Understanding & Translation of Verses	Past Tense صيغة المؤنث للغائب عبدتْ
15.	1.	7	8	Understanding & Translation of Verses	Passive Voice (Past Tense) فعل مجهول المفرد
	2.	7	9	Understanding & Translation of Verses	Passive Voice (Past Tense) فعل مجهول الجمع
16.	1.	8	1-4	Understanding & Translation of Verses	Imperative Verb for singular فعل الأمر للمفرد
	2.	7	5-8	Understanding & Translation of Verses	Imperative Verb for plural فعل الأمر للجمع

General Education Cluster: Arts & Humanities

URCG-5112 Fables, Wisdom Literature, and Epic 2(2-0)

The course will enable students to explore human experiences, cultivate an appreciation of the past, enrich their capacity to participate in the life of their times, and enable an engagement with other cultures and civilizations, both ancient and modern. But independently of any specific application, the study of these subjects teaches understanding and delight in the highest achievements of humanity. The three components of the course, including fables, wisdom literature and epic, will enable the learners to explore and understand the classic tradition in literature. Development of personal virtue, a deep Sufi ethic and an unwavering concern for the permanent over the fleeting and the ephemeral are some of the key themes explored in the contents that will develop an intimate connection between literature and life.

Contents

1. Fables
   - The Fables of Bidpai
   - The Lion and the Bull
   - The Ring-dove
   - The Owls and the Crows

   Selected poem from Bang-i-Dara

2. Gulistan-e- Sa'di
   Ten ḥikāyāt from John T. Platts, The Gulistan
3. Epic
   THE SHĀHNĀMA OF FIRDAUSI

Recommended Texts

1. John T. P. (1876). The Gulistan; or, Rose Garden of Shaikh Muslihu'd- Dīn Sa'dī of Shīrāz. London: Wm. II. Allen.
2. Chishti, Y.S. (1991). Sharaḥ-i bāng-i darā. Lāhaur: Maktaba-i ta'mīr-i insāniyat

Suggested Readings

1. Thackston, W. (2000). A Millennium of Classical Persian Poetry. Maryland: Ibex Publishers.
2. Wood, R. (2013). Kalila and Dimna: Fables of Conflict and Intrigue. United Kingdom: Medina Publishing, Limited.

General Education Cluster: Natural Sciences

URCG-5114 Course –I: Basic Science Cr. Hrs 3 (2-1)

Life, its characteristics, natural science, biology and its branches; Importance of Flora & Fauna in biodiversity; Importance of Natural Compounds in daily life, medicine and human health; Latest developments in natural sciences (Biotechnology); Ecosystem and its components; Environment and its components; Pollutants and their effect on the environment (Greenhouse effect, global warming, acid rains, water pollution and ozone depletions etc); Introduction to micro-organism and its types (bacteria, fungi, viruses)

Practical:

1: Field Survey of Flora & Fauna and their identification

2: Study of herbarium

3: Study of Museum

Recommended Texts.

1. Keddy, P.A. (2017). Plant ecology origins, processes, consequences. Cambridge, University Press.
2. Canadell, J.G., Diaz, S., Heldmaier, G., Jackson, R.B., Levia, D.F., Schulze, E.D. & Sommer, U. (20 19). Ecological studies. Springer.
3. Bhat, S.V., Nagasampagi, B.A. & Sirakumar, M. (2006). Chemistry of Natural Products. Springer Science
4. De, A.K. (2019). Environmental Chemistry. New Age International Press

Suggested Books

1. Fath, B. (2018). Encyclopedia of ecology. Elsevier.
2. Ajith, H .. Urmas. P., Pastur, G. M & Iversion L. R. (2018). Ecosystem services from forest landscpes: broadsclaes consideration. 1st Edition. Springer International Publishing AG.
3. Xu, R., Ye, Y. & Zhao, W. (2011). Introduction to Natural Product Chemistry. CRC Press
4. Tayler, D.J., Green, N.P.O. & Stout, G.W. (1997). Biological Science 1&2. Cambridge University Press
5. Tayler, M.R., Simon, E.J., Dickey, D.J. & Hogan, K.A. (2020). Campbell Biology: Concepts & Connections (10th Edition). Pearson

General Education Cluster: Social Sciences

URCG-5116 **Science of Society-I** 2 (2-0)

Course Description:

This course will introduce students with the subject matter of social science, its scope, nature and ways of looking at social phenomenon. It will make the participants acquaintance with the foundations of modern society, state, law, knowledge and selfhood. While retaining a focus on Pakistani state and society, students will encounter theoretical concepts and methods from numerous social science disciplines, including sociology, politics, economics anthropology and psychology and make them learn to think theoretically by drawing on examples and case studies from our own social context. Students will be introduced to the works of prominent social theorists from both western and non-western contexts. Instruction will include the use of written texts, audio-visual aids and field visits.

Learning Outcomes:

The course has following outcomes: It will

- Introduce student with the nature of human social behavior and foundations of human group life
- Analyze the reciprocal relationship between individuals and society.
- Make student aware with the nature of societies existing in modern world
- Make students familiar with the philosophy of knowledge of social sciences
- Introduce students with the works of prominent theories explain human group behavior
- Help students to understand the foundations of society including culture, socialization, politics and economy
- Introduce students with various dimensions of social inequalities with reference to gender, race, ethnicity and religion
- Make them aware about the understanding of various themes pertains to social science in local context
- Help them recognize the difference between objective identification of empirical facts, and subjective formulation of opinionated arguments

Course Outlines:

1. **Introduction to Social Sciences**
   - Social world, Human Social behavior, Foundations of society
   - Evolution of Social sciences
   - Philosophy of Science
   - Scope and nature of social sciences
   - Modernity and social sciences
   - Branches of social science: Sociology, Anthropology, Political Science, Economics
2. **Society and Community, Historical evolution of Society**
   - Types of Societies
   - Foraging society, Horticultural society, Pastoralist society
   - Agrarian societies, Industrial society, Postindustrial society
3. **Philosophy of Knowledge in social Science and social inquiry**
   - Understanding social phenomenon
   - Alternative ways of knowing
   - Science as a source to explore social reality
   - Objectivity, Value-Free research
   - Positivism vs Interpretivism
   - Qualitative vs Quantitative

4. **Culture and Society**
    - Idea of Culture, Assumptions of Culture
    - Types, Components, Civilization and culture
    - Individual and culture. Cultural Ethnocentrism, Cultural Relativism
    - Outlook of Pakistani culture
    - Global Flows of culture, Homogeneity, Heterogeneity

5. **Social Stratification and Social inequality**
    - Dimensions of inequality, Social class
    - Gender, Race, Religion, Ethnicity, Caste
    - Patterns of social stratification in Pakistan
    - Class, caste system in agrarian society
    - Ascription vs Achievement, Meritocracy
    - Global stratification in modern world, Global patterns of inequality

6. **Personality, Self and Socialization**
    - Concept of self, Personality
    - Nature vs Nurture, Biological vs Social
    - Development of Personality
    - Socialization as a process, Agents of socialization
    - Socialization and self/group identity

7. **Gender and Power**
    - Understanding Gender
    - Social construction of Patriarchy
    - Feminism in Historical context, Gender Debates
    - Gender and Development
    - Gender issues in Pakistani society, Women Participation in politics, economy and education
    - Toward a gender sensitive society, Gender mainstreaming

8. **Pakistan: State, Society, Economy and Polity**
    - Colonialism, colonial legacy, National identity
    - Transformation in Pakistani society: Traditionalism vs Modernism
    - Economy, Informality of Economy, Modern economy and Pakistan
    - Political Economy, Sociology of Economy

Recommended Textbooks and Reading Materials:

1. Giddens, A. (2018). Sociology (11th ed.). UK: Polity Press.
2. Henslin, J. M. (2018). Essentials of Sociology: A Down-to-Earth Approach.(18th Edition) Pearson Publisher.
3. Macionis, J. J. (2016). Sociology (16th ed.). New Jersey: Prentice-Hall.
4. Qadeer, M. (2006) Pakistan - Social and Cultural Transformation in a Muslim Nation.
5. Smelser, N.J. and Swedburg, R., The Handbook of Economic Sociology, Chapter 1 'Introducing Economic Sociology', Princeton University Press, Princeton.
6. Systems of Stratification | Boundless Sociology (no date). Available at: https://courses.lumenlearning.com/boundless-sociology/chapter/systems-of-stratification/

7. Jalal, A. (ed.) (1995) 'The colonial legacy in India and Pakistan', in Democracy and Authoritarianism in South Asia: A Comparative and Historical Perspective. Cambridge: Cambridge University Press (Contemporary South Asia)
8. Zaidi, S. A. (2015) Issues in Pakistan's Economy: A Political Economy Perspective. Oxford University Press. Chapter 26
9. Akhtar, A. S. (2017) The Politics of Common Sense: State, Society and Culture in Pakistan. Cambridge: Cambridge University Press.
10. Smelser, N.J. and Swedburg, R., The Handbook of Economic Sociology, Chapter 1 'Introducing Economic Sociology', Princeton University Press, Princeton.

URCG-5118 **Functional English** 3(3-0)

The course aims at providing understanding of a writer's goal of writing (i.e. clear, organized and effective content and to use that understanding and awareness for academic reading and writing. The objectives of the course are to make the students acquire and master the grammatical academic writing skills. The course would enable the students to develop argumentative writing techniques. The students would be able to logically add specific details on the topics such as facts, examples and statistical or numerical values. The course will also provide insight to convey the knowledge and ideas in an objective and persuasive manner. Furthermore, the course will also enhance the students' understanding of ethical considerations in writing academic assignments and topics including citation, plagiarism, formatting and referencing the sources as well as the technical aspects involved in referencing.

Contents

1. Developing Analytical Skills
2. Transitional devices (word, phrase and expressions)
3. Development of ideas in writing
4. Reading Comprehension
5. Precis Writing
6. Developing argument
7. Sentence structure: Accuracy, variation, appropriateness, and conciseness
8. Appropriate use of active and passive voice
9. Organization and Structure of a Paragraph
10. Organization and structure of Essay
11. Types of Essays

Recommended Texts

1. Bailey, S. (2011). Academic writing: A handbook for international students (3rd ed.). New York: Routledge.
2. Eastwood, J. (2011). A Basic English grammar. Oxford: Oxford University Press.
3. Swales, J. M., & Feak, C. B. (2012). Academic writing for graduate students: Essential tasks and skills (3rd ed.). Ann Arbor: The University of Michigan Press.
4. Swan, M. (2018). Practical English usage (8th ed.). Oxford: Oxford University Press.

Suggested Readings

1. Biber, D., Johansson, S., Leech, G., Conrad, S., Finegan, E., & Quirk, R. (1999). Longman grammar of spoken and written English. Harlow Essex: MIT Press.
2. Cresswell, G. (2004). Writing for academic success. London: SAGE.
3. Johnson-Sheehan, R. (2019). Writing today. Don Mills: Pearson.
4. Silvia, P. J. (2019). How to write a lot: A practical guide to productive academic writing. Washington: American Psychological Association
5. Thomson, A. J., & Martinet, A. V. (1986). A Practical English Grammar. Oxford: Oxford University Press

URCG- 5119 **Expository Writing** 3 (3-0)

This course prepares undergraduates to become successful writers and readers of English. The course helps students develop their fundamental language skills with a focus on writing so that they can gain the confidence to communicate in oral and written English outside the classroom. The course is divided into five units and takes a Project-based Learning approach. Unit themes target the development of 21st century skills and focus on self-reflection and active community engagement. The course completion will enable the students to develop communication skills as reflective and self-directed learners. They will be able to intellectually engage with different stages of writing process, and develop analytical and problem-solving skills to address various community-specific challenges.

Contents

1. Self-Reflection
   - Introduction to the basics of the writing process
   - Introduction to the steps of essay writing
   - Prewriting activities: Brainstorming, listing, clustering and free writing
   - Practicing Outlining of the essay
2. Personalized Learning
   - Learning Process, Learning Styles, Goal Setting and Learning Plan
3. Oral Presentation
   - Structure and Significance, Content Selection and Slide Presentation, Peer Review
4. Critical Reading Skills
   - Introducing Authentic Reading (Dawn and non-specialist academic books/texts)
   - Reading Strategies and Practice: Skimming, scanning, SQW3R, Annotating, Detailed reading and note-taking, Standard Test Practice: TOEFL and IELTS, Model Review Reports and Annotated Bibliographies
5. Community Engagement
   - Student-led brainstorming on local versus global issues, Identifying research problems
   - Drafting research questions, Drafting interview/survey questions for community research (in English or L1)
   - Engaging students in Critical reading, Presenting interview/ survey information, Field work
   - Writing Community Engagement Project
6. Letter to the Editor
   - Types of letters, Format and purpose of letter to the editor, Steps in writing letter-to-editor

Recommended Texts

1. Bailey, S. (2011). Academic writing: A handbook for international students (3rd ed.). New York: Routledge.
2. Swales, J. M., & Feak, C. B. (2012). Academic writing for graduate students: Essential tasks and skills (3rd ed.). Ann Arbor: The University of Michigan Press.

Suggested Readings

1. Cresswell, G. (2004). Writing for academic success. London: SAGE.
2. Johnson-Sheehan, R. (2019). Writing today. Don Mills: Pearson.
3. Silvia, P. J. (2019). How to write a lot: A practical guide to productive academic writing. Washington: American Psychological Association.

Annex-A

URCG-5120 Exploring Quantitative Skills 3(3+0)

This is an introductory-level undergraduate course that focuses on the fundamentals related to the quantitative concepts and analysis. The course is designed to familiarize students with the basic concepts of mathematics and statistics and to develop students' abilities to analyze and interpret quantitative information. Through a combination of theoretical concepts and practical exercises, this course will also enable students cultivate their quantitative literacy and problem solving skills while effectively expanding their academic horizon and breadth of knowledge of their specific major / field of study.

Course Learning Outcomes

By the end of this course, students shall have:

1. Fundamental numerical literacy to enable them work with numbers, understand their meaning and present data accurately;
2. Understanding of fundamental mathematical and statistical concepts;
3. Basic ability to interpret data presented in various formats including but not limited to tables, graphs, charts, and equations etc.

Contents

1. Numerical Literacy:

i. Numbers system and basic arithmetic operations;
ii. Units and their conversions, dimensions, area, perimeter and volume;
iii. Rates, ratios, proportions and percentages;
iv. Types and sources of data;
v. Measurement, scales;
vi. Tabular and graphical presentation of data;
vii. Quantitative reasoning exercises using number knowledge.

2. Fundamental mathematical concepts:

i. Basics of geometry (lines, angles, circles, polygons etc.);
ii. Sets and their operations;
iii. Relations, functions, and their graphs;
iv. Exponents, factoring and simplifying algebraic expressions;
v. Algebraic and graphical solutions of linear and quadratic equations and inequalities;
vi. Quantitative reasoning exercises using fundamental mathematical concepts.

3. Fundamental Statistical Concepts:

i. Population and sample;
ii. Measures of central tendency, dispersion and data interpretation;
iii. Rules of counting (multiplicative, permutation and combination);
iv. Basic probability theory;
v. Introduction to random variables and their probability distributions;
vi. Quantitative reasoning exercises using fundamental statistical concepts.

Recommended Texts

1. Sevilla, A., & Somers, K. (2012). *Quantitative reasoning: tools for today's informed citizen*. New Jersey. John Wiley & Sons.

Barzynski, D., & Ellis, W. (2008). *Fundamentals of mathematics*. USA, Saunders College Publishing

Suggested Readings

1. Zaslow, L. (2020). *Quantitative reasoning: thinking in numbers*. Cambridge, Cambridge University Press.
2. de Mesquita, E. B., & Fowler, A. (2021). *Thinking clearly with data: A guide to quantitative reasoning and analysis*. New Jersey, Princeton University Press.
3. Bennett, J., & Briggs, W. (2019). *Using & understanding mathematics: a quantitative reasoning approach*. Pearson.
4. Rosen, K. H., & Krithivasan, K. (2012). *Discrete mathematics and its applications* (Vol. 6). New York: McGraw-Hill.
5. Chatfield, C. (2018). *Statistics for technology: a course in applied statistics*. Routledge.
6. Lock, R. H., Lock, P. F., Morgan, K. L., Lock, E. F., & Lock, D. F. (2020). *Statistics: Unlocking the power of data*. New Jersey, John Wiley & Sons.

Annex-'B'

URCG-512b **Tools for Quantitative Reasoning** 3(3+0)

This is a sequential undergraduate course that focuses on logical reasoning supported with mathematical and statistical concepts and modeling / analysis techniques to equip students with analytical skills and critical thinking abilities necessary to navigate the complexities of the modern world. The course is designed to familiarize students with the quantitative concepts and techniques required to interpret and analyze numerical data and to inculcate ability in students the logical reasoning to construct and evaluate arguments, identify fallacies, and think systematically. Keeping the pre-requisite course of Quantitative reasoning (I) as its base, this course will enable students further their quantitative. Logical and critical reasoning abilities to complement their specific major field of study

Course Learning Outcomes

By the end of the course, student shall have:

1. Understanding of logic and logical reasoning;
2. Understanding the basic quantitative Modeling and Analyses.
3. Logical reasoning skills and abilities to apply them to solve quantitative problems and evaluate arguments;
4. Ability to critically evaluate quantitative information to make evidence based decisions through appropriate computational tools.

Contents

1. *Logic, Logical and Critical Reasoning:*
   - i. Introduction and importance of logic,
   - ii. Introductive, deductive and abductive approaches of reasoning,
   - iii. Propositions, arguments (valid; invalid), logical connectives, truth tables and propositional equivalences,
   - iv. Logical fallacies,
   - v. Venn Diagrams,
   - vi. Predicates and quantifiers,
   - vii. Quantitative reasoning exercises using logical reasoning concepts and techniques.
2. *Mathematical Modeling and Analyses:*
   - i. Introduction to deterministic models,
   - ii. Use of linear function for modeling in real-world situations,
   - iii. Modeling with the system of linear equation and their solutions,
   - iv. Elementary introduction to derivatives in mathematical modeling,
   - v. Linear and experiential growth and decay models,
   - vi. Quantitative reasoning exercises using mathematical modeling.
3. *Statistical Modeling and Analyses:*
   - i. Introduction to probabilistic models,
   - ii. Bivariate analysis, scatter plots,
   - iii. Simple linear regression model and correlation analysis,
   - iv. Basics of estimation and confidence interval,
   - v. Testing of hypothesis (z-test; t-test),
   - vi. Statistical inference in decision making,
   - vii. Quantitative reasoning exercise using statistical modeling.

- Barzynski, B., & Ellis, W. (2008). *Fundamentals of mathematics*. USA, Saunders College Publishing.

Suggested Readings

1. Zaslow, E. (2020). *Quantitative reasoning: thinking in numbers*. Cambridge. Cambridge University Press.
2. de Mesquita, E. B., & Fowler, A. (2021). *Thinking clearly with data: A guide to quantitative reasoning and analysis*. New Jersey, Princeton University Press.
3. Bennett, J., & Briggs, W. (2019). *Using & understanding mathematics: a quantitative reasoning approach*. Pearson.
4. Rosen, K. H., & Krithivasan, K. (2012). *Discrete mathematics and its applications* (Vol. 6). New York: McGraw-Hill.
5. Chatfield, C. (2018). *Statistics for technology: a course in applied statistics*. Routledge.
6. Lock, R. H., Lock, P. F., Morgan, K. L., Lock, E. F., & Lock, D. F. (2020). *Statistics: Unlocking the power of data*. New Jersey, John Wiley & Sons.

URCG-5105 **Islamic Studies (Compulsory)** 2(2-0)

Introductory/compulsory foundation course

Islamic Studies engages in the study of Islam as a textual tradition inscribed in the fundamental sources of Islam: Qur'aan and Hadith, history and particular cultural contexts. The area seeks to provide an introduction to and a specialization in Islam through a large variety of expressions (literary, poetic, social, and political) and through a variety of methods (literary criticism, hermeneutics, history, sociology, and anthropology). It offers opportunities to get fully introductory foundational basis of Islam in fields that include Qur'aanic studies, Hadith and Seerah of Prophet Muhammad (PBUH), Islamic philosophy, and Islamic law, culture and theology through the textual study of Qur'aan and Sunnah.

- To make students understand the relevance and pragmatic significance of Islam in theirlives.
- To make learners comprehend the true spirit of Islam with reference to modernworld.
- To generate a sense of Islamic principles as a code of living that guarantee the effective solutions to the current challenges ofbeing.
- To provide Basic information about IslamicStudies
- To enhance understanding of the students regarding IslamicCivilization
- To improve Students skill to perform prayers and otherworships
- To enhance the skill of the students for understanding the issues related to faith and religious life.

Contents

1.Introduction to Qur'aanic Studies تعارف قرآن مجید

1) Basic Concepts of Qur'aan قرآن مجید کا بنیادی تعارف

2) History of the compilation of Qur'aa تاریخ جمع وتدوین قرآن مجید

3) Uloom-ul-Qur'aan علوم القرآن

مطالعہ قرآن (تعارف قرآن مجید، منتخب آیات کا ترجمہ و تفسیر: سورۃ البقرہ آیات 1-5، 284-286؛ سورۃ الحجرات آیات 1-18؛ سورۃ الفرقان آیات 63-77؛ سورۃ المومنون آیات 1-11؛ سورۃ الاحزاب آیات 6، 21، 32- 33، 40، 56- 59؛ سورۃ الانعام آیات 151-153؛ سورۃ الصف آیات 1- 14؛ الحشر آیات 18- 20؛ آل عمران آیات 190- 192؛ النحل آیات 12-14؛ لقمن آیت 20، حم السجدہ آیت 53

2. Introduction to Hadith تعارف حدیث

1) Legal Status of Hadith حدیث کی قانونی حیثیت

2) History of the compilation of Hadith تاریخ جمع وتدوین حدیث

3) Classifications of Hadith حدیث کی اقسام

Chairman
Department of Islamic Studies
... of Sargodha

متن، حدیث: 1 درج ذیل موضوعات پر احادیث کا مطالعہ

1۔ اعمال کا اجر نیت پر منحصر ہے۔ 2۔ بہترین انسان قرآن کا طالب علم اور اس کا معلم ہے۔ 3۔ کتاب و سنت گمراہی سے بچنے کا ذریعہ ہیں 4۔ ارکان اسلام 5۔ اسلام، ایمان، احسان اور قیامت کی نشانیاں، 6۔ بچوں کو نماز کی تلقین 7۔ دین کا گہرا فہم اللہ کی خاص عنایت ہے 8۔ حصول علم، تلاوتِ قرآن اور عمل کی اہمیت و فضیلت، 9۔ روز محشر میں ہونے والا محاسبہ، 10۔ حقوق اللہ کے ساتھ ساتھ حقوق العباد کا لحاظ رکھنا بھی لازم ہے 11۔ حسن خلق کی عظمت اور فحش و بدگوئی کی مذمت 12۔ دنیا و آخرت کی بھلائی کی ضامن چار چیزیں، 13۔ ہلاک کر دینے والی سات چیزیں، 14۔ بے عمل مبلغ کا عبرت ناک انجام 15۔ ہر شخص نگران ہے اور ہر شخص مسئول

3. Sirah of the Prophet (PBUH)	سیرت النبی ﷺ
1. Significance of Seerah Studies	مطالعہ سیرت کی ضرورت و اہمیت
2. Prophetic principles of Character building	تعمیر سیرت و شخصیت کا نبوی منہاج

اقامت دین کا نبوی طریق کار، اقامتِ دین بعہد خلافت راشدہ، میثاق مدینہ، خطبہ حجۃ الوداع، اخلاقی تعلیمات، تشکیل اجتماعیت اور اسوہ حسنہ، قرآن مجید میں سیرت سرور عالم کا بیان، غزواتِ نبوی ﷺ کے مقاصد و حکمتیں

4. Islamic Culture & Civilization	اسلامی تہذیب و تمدن
1) Basic Concepts of Islamic Civilization	اسلامی تہذیب کا مفہوم
2) Historical evaluation of Islamic Civilization	اسلامی تہذیب کا تاریخی ارتقاء
3) Salient feature of Islamic Civilization	اسلامی تہذیب کی نمایاں خصوصیات
4) Islamic Civilization and ContemporaryIssues	اسلامی تہذیب و تمدن اور معاصر مسائل

اسلامی تہذیب کے عوامل و عناصر، اسلامی تہذیب کے علمی، معاشرتی اور سماجی اثرات، تہذیبوں کے تصادم کے نظریے کا تنقیدی جائزہ، تہذیبی تصادم کے اثرات و نتائج، طبعی، حیاتیاتی اور معاشرتی علوم میں مسلمانوں کا کردار، نامور مسلمان سائنسدان

Pre-Requisite: Nil

Recommended Books

1) Hameed ullahMuhammad, —Emergence ofIslam ,IRI,Islamabad
2) Hameed ullah Muhammad, —Muslim Conduct ofState
3) Hameed ullah Muhammad, _Introduction toIslam
4) Ahmad Hasan, —Principles of Islamic Jurisprudence, Islamic Research Institute, International Islamic University, Islamabad (1993)
5) Dr.Muhammad Zia-ul-Haq,—Introduction to Al Sharia Al Islamia, Allama Iqbal Open University, Islamabad(2001)
6) Dr. Muhammad Shahbaz Manj, Teleeemat-e- Islam

URCG-5122 **Ideology and Constitution of Pakistan** 2(2-0)

Course Description:

This course focuses on ideological background of Pakistan. The course is designed to give a comprehensive insight about the constitutional developments of Pakistan. Starting from the Government of India Act, 1935 till to date, all important events leading to constitutional developments in Pakistan will be the focus of course. Failure of the constitutional machinery and leading constitutional cases on the subject. Moreover, students will study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan. It will also cover the entire Constitution of Pakistan 1973. However, emphasis would be on the fundamental rights, the nature of federalism under the constitution, distribution of powers, the rights and various remedies, the supremacy of parliament and the independence of judiciary

Outline:

- **Ideology of Pakistan**
  - Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-e-Azam Muhammad Ali Jinnah.
  - Two Nation Theory and Factors leading to Muslim separatism.
- **Constitutional Developments**
  - Salient Feature of the Government of India Act 1935
  - Salient Feature of Indian Independence Act 1947
  - Objectives Resolution
  - Salient Feature of the 1956 Constitution
  - Developments leading to the abrogation of Constitution of 1956
  - Salient features of the 1962 Constitution
  - Causes of failure of the Constitution of 1962
  - Comparative study of significant features of the Constitution of 1956, 1962 and 1973
- **Fundamental rights**
- **Principles of policy**
- **Federation of Pakistan**
  - President
  - Parliament
  - The Federal Government
- **Provinces**
  - Governors
  - Provincial Assemblies
  - The Provincial Government
- **The Judicature**
  - Supreme Court
  - High Courts
  - Federal Shariat Courts
  - Supreme Judicial Council
  - Administrative Courts and tribunals
- **Islamic Provisions in Constitution**
- **Significant Amendments of Constitution of Pakistan 1973**

Recommended Books:

1. Constitutional and Political History of Pakistan by Hamid Khan
2. Mahmood, Shaukat and Shaukat, Nadeem. Constitution of the Islamic Republic of Pakistan, 3rd re edn. Lahore: Legal Research Centre, 1996.
3. Munir, Muhammad. Constitution of the Islamic Republic of Pakistan: Being a Commentary on the Constitution of Pakistan, 1973. Lahore, Law Pub., 1975.
4. Rizvi, Syed Shabbar Raza. Constitutional Law of Pakistan: Text, Case Law and Analytical Commentary. 2nd re edn. Lahore: Vanguard, 2005.
5. The Text of the Constitution of the Islamic Republic of Pakistan, 1973 (as amended).
6. Fundamental Laws of Pakistan by A.K. Brohi

URCG-5123 Applications of Information Communication Technologies (ICT) 3 (2-1)

The course introduces students to information and communication technologies and their application in the workplace. Objectives include basic understanding of computer software, hardware, and associated technologies. How computers can be used in the workplace, how communications systems can help boost productivity, and how the Internet technologies can influence the workplace. Students will get basic understanding of computer software, hardware, and associated technologies. They will also learn how computers are used in the workplace, how communications systems can help to boost productivity, and how the Internet technologies can influence the workplace.

Contents

1. Introduction, Overview of Information Technology.
2. Hardware: Computer Systems & Components, Storage Devices.
3. Software: Operating Systems, Programming and Application Software.
4. Databases and Information Systems Networks.
5. File Processing Versus Database Management Systems.
6. Data Communication and Networks.
7. Physical Transmission Media & Wireless Transmission Media.
8. Applications of smart phone and usage.
9. The Internet, Browsers and Search Engines.
10. Websites and their types.
11. Email Collaborative Computing and Social Networking.
12. E-Commerce.
13. IT Security and other issues.
14. Cyber Laws and Ethics of using Social media.
15. Use of Microsoft Office tools (Word, Power Point, Excel) or other similar tools depending on the operating system.
16. Other IT tools/software specific to field of study of the students if any.

Recommended Book

1. Discovering Computers 2022: Digital Technology, Data and Devices by Misty E. Vermaat, Susan L. sebok; 17th edition.

Suggested Books

1. Computing Essentials 2021 by Timothy J. O'Leary and Linda I. O'Leary, McGraw Hill Higher Education; 26th edition.
2. Computers: Understanding Technology by Fuller, Floyd; Larson, Brian: edition 2018.

URCG-5124 **Entrepreneurship** 2(2-0)

This course addresses the unique entrepreneurial experience of conceiving, evaluating, creating, managing, and potentially selling a business idea. The goal is to provide a solid background with practical application of important concepts applicable to the entrepreneurial environment. Entrepreneurial discussions regarding the key business areas of finance, accounting, marketing and management include the creative aspects of entrepreneurship. The course relies on classroom discussion, participation, the creation of a feasibility plan, and building a business plan to develop a comprehensive strategy for launching and managing a new venture.

Course Learning Objectives

1. To enhance the 'entrepreneurial intentions' of the students by improving their natural willingness to start a business.
2. To understand the process of entrepreneurship and learn the ways to manage it by working individually in the class and in the form of groups outside the class to conduct field assignments.
3. To educate the students about the practical underpinnings of the entrepreneurship with the aid of practical assignments and idea pitching.

Contents

1. **Background:** What is an Organization, Organizational Resources, Management Functions, Kinds of Managers, Mintzberg's Managerial Roles.
2. **Forms of Business Ownership:** The Sole proprietorship, Partnership, Joint Stock Company
3. **Entrepreneurship:** The World of the Entrepreneur, what is an entrepreneur? The Benefits of Entrepreneurship, The Potential Drawbacks of Entrepreneurship, Behind the Boom: Feeding the Entrepreneurial Fire.
4. **The Challenges of Entrepreneurship:** The Cultural Diversity in Entrepreneurship, The Power of "Small" Business, Putting Failure into Perspective, The Ten Deadly Mistakes of Entrepreneurship, How to Avoid the Pitfalls, Idea Discussions & Selection of student Projects, Islamic Ethics of Entrepreneurship.
5. **Inside the Entrepreneurial Mind:** From Ideas to Reality: Creativity, Innovation, and Entrepreneurship, Creativity – Essential to Survival, Creative Thinking, Barriers to Creativity, How to Enhance Creativity, The Creative Process, Techniques for Improving the Creative Process, Protecting Your Ideas, Idea Discussions & Selection of student Projects.
6. **Products and technology, identification opportunities**
7. **Designing a Competitive Business Model and Building a Solid Strategic Plan:** Building a strategic plan, Building a Competitive Advantage, The Strategic Management Process, Formulate strategic options and select the appropriate strategies, Discussion about execution of Students' Project.
8. **Conducting a Feasibility Analysis and Crafting a Winning Business Plan:** Conducting a Feasibility Analysis, Industry and market feasibility, Porter's five forces model, Financial feasibility analysis. Why Develop a Business Plan, The Elements of a Business Plan, What Lenders and Investors Look for in a Business Plan, Making the Business Plan Presentation.
9. **Building a Powerful Marketing Plan:** Building a Guerrilla Marketing Plan, Pinpointing the Target Market, Determining Customer Needs and Wants Through Market Research. Plotting a Guerrilla Marketing Strategy: How to Build a Competitive Edge, Feed Back & Suggestions on Student Project, Islamic Ethics for Entrepreneurial Marketing

10. **E-Commerce and the Entrepreneur:** Factors to Consider before Launching into E-Commerce, Ten Myths of E-Commerce, Strategies for E-Success, Designing a Killer Web Site, Tracking Web Results, Ensuring Web Privacy and Security, Feed Back & Suggestions on Student Project.
11. **Pricing Strategies:** Three Potent Forces: Image, Competition, and Value, Pricing Strategies and Tactics, Pricing Strategies and Methods for Retailers, The Impact of Credit on Pricing
12. **Attracting Venture Capitalist:** Projected Financial Statements, Basic Financial Statements, Ratio Analysis, Interpreting Business Ratios, Breakeven Analysis, Feed Back &Suggestions on Student Project,
13. **Idea Pitching:** Formal presentation, 5-minutes pitch, funding negotiation and launching.

Recommended Texts:

1. Scarborough, N. M. (2011). Essentials of entrepreneurship and small business management. Publishing as Prentice Hall, One Lake Street, Upper Saddle River, New Jersey 07458.

Suggested Readings:

1. Burstiner, I. (1989). Small business handbook. Prentice Hall Press.

URCG-5125 **Civics and Community Engagement** 2(2-0)

Course Description:
The Civics and Community Engagement course is designed to provide students with an understanding of the importance of civic participation, culture and cultural diversity, basic foundations of citizenship, group identities and the role of individuals in creating positive change within their communities. The course aims at developing students' knowledge, skills and attitudes necessary for active and responsible citizenship.

Learning outcomes
After completing this course, students will be able to

- Understand the concepts of civic engagement, community development, and social responsibility.
- Understand rights and responsibilities of citizenship
- Understand cultural diversity in local and global context
- Analyze significance of civic participation in promoting social justice, equity and democracy.
- Examine the historical and contemporary examples of successful civic and community engagement initiatives.
- Identify and assess community needs, assets, and challenges to develop effective strategies for community improvement.
- Explore the ethical implications and dilemmas associated with civic and community engagement.
- Develop practical skills for effective community organizing, advocacy, and leadership.
- Foster intercultural competence and respect for diversity in community engagement efforts.
- Collaborate with community organizations, stakeholders, and fellow students to design and implement community-based projects.
- Reflect on personal growth and learning through self-assessment and critical analysis of community engagement experiences.

Course Content:

Introduction to Civics & Community Engagement

- Overview of the course: Civics & Community Engagement
- Definition and importance of civics
- Key concepts in civics: citizenship, democracy, governance, and the rule of law
- Rights and responsibilities of citizens

Citizenship and Community Engagement

- Introduction to Active Citizenship: Overview of the Ideas, Concepts, Philosophy and Skills
- Approaches and Methodology for Active Citizenship

Identity, Culture, and Social Harmony

- Concept and Development of Identity, Group identities
- Components of Culture, Cultural pluralism, Multiculturalism, Cultural Ethnocentrism, Cultural relativism, Understanding cultural diversity, Globalization and Culture, Social Harmony,
- Religious Diversity (Understanding and affirmation of similarities & differences)
- Understanding Socio-Political Polarization
- Minorities, Social Inclusion, Affirmative actions

Multi-cultural society and inter-cultural dialogue

- Inter-cultural dialogue (bridging the differences, promoting harmony)
- Promoting intergroup contact/ Dialogue
- Significance of diversity and its impact
- Importance and domains of Inter-cultural dialogue

Active Citizen: Locally Active, Globally Connected

- Importance of active citizenship at national and global level
- Understanding community
- Identification of resources (human, natural and others)
- Utilization of resources for development (community participation)
- Strategic planning, for development (community linkages and mobilization)

Human rights, constitutionalism and citizens' responsibilities

- Introduction to Human Rights
- Human rights in constitution of Pakistan
- Public duties and responsibilities
- Constitutionalism and democratic process

Social Institutions, Social Groups, Formal Organizations and Bureaucracy

- Types of Groups, Group identities, Organizations
- Bureaucracy, Weber's model of Bureaucracy
- Role of political parties, interest groups, and non-governmental organizations

Civic Engagement Strategies

- Grassroots organizing and community mobilization
- Advocacy and lobbying for policy change
- Volunteerism and service-learning opportunities

Social issues/Problems of Pakistan

- Overview of major social issues of Pakistani society

Social Action Project

Recommended Books:

1. Kennedy. J. K., & Brunold, A. (2016). Regional context and Citizenship education in Asia and Europe. New Yourk: Routledge, Falmer.
2. Henslin, James M. (2018). Essentials of Sociology: A Down to Earth Approach (13th ed.). New York: Pearson Education
3. Macionis, J. J., & Gerber, M.L. (2020). Sociology. New York: Pearson Education

Reference Books:

1. Glencoe McGraw-Hill. (n.d.). Civics Today: Citizenship, Economics, and Youth.
2. Magleby, D. B., Light, P. C., & Nemacheck, C. L. (2020). Government by the People (16th ed.). Pearson.
3. Sirianni, C., & Friedland, L. (2005). The Civic Renewal Movement: Community-Building and Democracy in the United States. Kettering Foundation Press.
4. Bloemraad, I. (2006). Becoming a Citizen: Incorporating Immigrants and Refugees in the United States and Canada. University of California Press.
5. Kuyek, J. (2007). Community Organizing: Theory and Practice. Fernwood Publishing.
6. DeKieffer, D. E. (2010). The Citizen's Guide to Lobbying Congress. TheCapitol.Net.
7. Rybacki, K. C., & Rybacki, D. J. (2021). Advocacy and Opposition: An Introduction to Argumentation (8th ed.). Routledge.
8. Kretzmann, J. P., & McKnight, J. L. (1993). Building Communities from the Inside Out: A Path Towards Finding and Mobilizing a Community's Assets. ACTA Publications.
9. Patterson, T. E. (2005). Engaging the Public: How Government and the Media Can Reinvigorate American Democracy. Oxford University Press.
10. Love, N. S., & Mattern, M. (2005). Doing Democracy: Activist Art and Cultural Politics. SUNY Press.

Title	Description
Semester	
Nature of Course	
Total Teaching weeks	18
Objectives of the Course	۱۔طلباء کو مطالعہ سیرۃ طیبہ کی ضرورت و اہمیت سے آگاہ کرنا ۲۔ تعمیر شخصیت میں مطالعہ سیرۃ طیبہ کے کردار کو واضح کرنا ۳۔بعثت نبوی کے موقع پر اقوام عالم کی عمومی صورت حال سے آگاہ کرنا ۴۔رسول اکرم صلی اللہ علیہ وسلم کی مکی اور مدنی زندگی کا اس طرح مطالعہ کروانا کہ طلباء ان واقعات سے نتائج کا استنباط کر سکیں ۵۔ طلباء کوعہد نبوی کی معاشرت ، سیاست ، معیشت سے آگاہ کرنا

Course Description

S.No.	Title	Description
1	حضور صلی اللہ علیہ وسلم کے ابتدائی حالاتِ زندگی	۱۔ حضور صلی اللہ علیہ وسلم کا خاندانی حسب و نسب ۲۔ پیدائش اور ابتدائی تربیت ۳۔ لڑکپن اور جوانی کے حالات زندگی
2	بعثت نبوی کے وقت دنیا کے حالات(۱)	۱۔ بعثت نبوی کے وقت اہم تہذیبیں ۲۔ عرب، مصر، حبشہ، بازنطینی، ساسانی
3	بعثت نبوی	۱۔ مکی عہد میں دعوت اسلام
4	بعثت نبوی	۱۔ مدنی عہد میں دعوت اسلام
5	خصائص النبیؐ	آپؐ بطور پیغامبر امن
6	خصائص النبیؐ	بحثیت استاد و معلم
7	خصائص النبیؐ	بحثیت تاجر
8	خصائص النبیؐ	بحثیت سربراہ ریاست
9	خصائص النبیؐ	ذاتی محاسن اور عالمگیر اثرات
10	خصائص النبیؐ	ناموس رسالتؐ
11	اسوہ حسنہ اور عصر حاضر	غیر مسلموں سے تعلقات
12	اسوہ حسنہ اور عصر حاضر	اسوہ حسنہ کی روشنی میں گھریلو زندگی
13	اسوہ حسنہ اور عصر حاضر	مستشرقین اور مطالعہ سیرت
15	اسوہ حسنہ اور عصر حاضر	وطن سے محبت اور سیرت
16	اسوہ حسنہ اور عصر حاضر	مستشرقین کے اعتراضات اور ان کے جوابات

نصابی کتب

نمبر شمار	نام مؤلف	نام کتاب
1	ابن ہشام	السیرۃ النبویۃ
2	مولاناشبلی نعمانی ، سید سلمان ندوی	سیرۃ النبی صلی اللہ علیہ وسلم
3	قاضی محمد سلیمان سلمان منصور پوری	رحمۃ اللعالمین
4	مولانا سیدابو الحسن علی ندوی	نبی رحمت صلی اللہ علیہ وسلم
5	ڈاکٹر یسین مظہر صدیقی	عہد نبوی کا نظام حکومت
6	ڈاکٹر خالد علوی	انسان کامل

حوالہ جاتی کتب

نمبر شمار	نام مؤلف	نام کتاب
1	سید ابوالاعلیٰ مودودی	سیرت سرور عالم صلی اللہ علیہ وسلم
2	مولانا صفی الرحمن مبارکپوری	الرحیق المختوم
3	پیر محمد کرم شاہ الازہری	ضیاء النبی صلی اللہ علیہ وسلم
4	ڈاکٹر اکرم الضیاء العمری	السیرۃ النبویۃ الصحیحۃ
5	مولاناعبدالرؤف دانا پوری	اصح السیر

URCG-5128 **Pakistan Studies** 2(2-0)

This course is designed to provide students with a comprehensive exploration of Pakistan's identity, spanning geographical, historical and cultural dimensions. It delves into the diverse landscape, ancient civilizations, and rich cultural heritage that define Pakistan. Moreover, it examines the socio-cultural and political transformations in Pakistan over time including democratic transitions and military interventions. The aim of this course is to inculcate in students a nuanced understanding of Pakistan's past, present, and potential future trajectories, enabling them to critically evaluate the complex dynamics shaping the nation's development.

Course Learning Outcomes

By the end of this course, student will be able to:

1. Have enhanced knowledge of the geographical, historical and political aspects of Pakistan.
2. Understand the society and cultural of Pakistan.
3. Understand and explain the scio-economics developments in Pakistan.
4. Explore contemporary issues and challenges faced by Pakistan and their implications for the future.

Contents

1. **Introduction to Pakistan:**
   - Geographical location and significance.
   - Historical background: Ancient civilizations in the region.
   - Factors leading to the creation of Pakistan
2. **Political History of Pakistan:**
   - Formative phase
   - Military interventions and democratic transitions.
3. **Geography of Pakistan:**
   - Physiography: Mountains, plains, plateaus, deserts, valleys and coastal areas.
   - River system: Indus river and its tributaries;
   - Climatic regions of Pakistan.
4. **Society and Culture of Pakistan:**
   - Socio- cultural diversity.
   - Language and literature of Pakistan.
5. **Economics Development of Pakistan:**
   - Agriculture and industrial sectors of Pakistan.
   - Economic challenges of Pakistan.
6. **Contemporary Issues:**
   - Foreign relations of Pakistan.
   - Security challenges: terrorism, extremism, regional conflicts.
   - Environmental problems and sustainable development (SDGs).
   - Media and social change.

SUGGESTED READING MATERIALS

1. "Jinnah of Pakistan" by Stanley Wolpert
2. "The sole Spokesman: Jinnah, the Muslim League, and the Demand for Pakistan" by Ayesha Jalal
3. "The struggle for Pakistan" by Ishtiaq Hussain Qureshi
4. "Pakistan, the Formative Phase, 1857-1948" by Khalid B. Sayeed
5. "Pakistan Studies: A Book of Readings" by Sikandar Hayat
6. "Constitutional and Political History of Pakistan" by Hamid Khan
7. "Trek to Pakistan" by Ahmad Saeed and Kh. Mansur Sarwar
8. "Pakistan: A Modern History" by Ian Talbot
9. "Politics in Pakistan: The Nature and Direction of Change" by Khalid B. Sayeed
10. "Physical Geography of Pakistan" by Umar Jahangir
11. "A Geography of Pakistan: Environment, people, and Economy" by Fazle Karim Khan
12. "Pakistan's Foreign Policy: An Historical Analysis" by S.M. Burke
13. "Separatism in East Pakistan" by Rizwan Ullah Kokab
14. "Being Pakistani: Society, Culture and the Arts" by Raza Rumi
15. "Pakistani's Culture Heritage: Socio-Economic and Technological Aspects" edited by Abdul Jabbar Khan
16. "Language and Politics in Pakistan" by Tariq Rahman
17. Sociology" by Horton and Hunt
18. "Pakistan in the Twentieth Century: A Political History" by Lawrence Ziring
19. "Economic Development of Pakistan" by Ishrat Husain
20. "Issues in Pakistan's Economy" by S. Zaidi

PICS-5110 **Chinese Language** **2(2-0)**

This course is designed to help learners achieve a foundational to lower-intermediate level in Mandarin Chinese, integrating both HSK 1 and HSK 2 Standard Courses. The focus is on developing practical language skills for real-life communication. Students will gain proficiency in listening, speaking, reading, and writing by learning commonly used vocabulary, grammatical structures, and sentence patterns. The course adopts a topic-based approach, making the content engaging and easy to relate to daily situations. By the end of the course, learners will be able to handle simple interactions and express basic ideas in Chinese. This course brief clearly outlines the course's objectives, approach, and expected outcomes, providing a concise overview of what learners can expect to achieve.

Contents

HSK 1 – HSK 2 (20 Lessons)

1. Greetings and Introductions, Numbers and Family Members
2. Dates, Days, and Time, Learning Chinese and Asking Locations
3. Jobs and Hobbies, Weather and Food
4. Shopping and Asking Prices, Transportation and Directions
5. Describing People and Actions
6. Daily Conversations and Integration
7. Daily Life and Time Expressions
8. Places and Getting Around
9. Shopping and Health
10. Talking About Past Experiences
11. School Life and Exams
12. Making Comparisons and Describing Abilities
13. Appointments and Invitation
14. Feelings and Personal Preferences
15. Narrating Past Events
16. Practical Dialogues and Communication

Note:

- The Vocabulary Coverage in HSK 1 course is approximately 150 words includes basic nouns, verbs, pronouns, question words, and daily expressions (e.g., 你好, 谢谢, 请, 是, 不, 什么, 哪儿, 吃, 学习).
- The Vocabulary Coverage in HSK 2 course is approximately 150 words (Total 300 with HSK 1) includes extended verbs, adjectives, time expressions, comparative structures, and more conversational vocabulary (e.g., 可以, 因为, 所以, 比, 觉得, 非常, 一起).

Recommended Texts

1. Jiang, L. (2014). *HSK Standard Course 1*. Beijing Language and Culture University Press.
2. Jiang L. (2014). *HSK Standard Course 2*. Beijing Language and Culture University Press.

Suggested Readings

1. *HSK 1 & 2 Official Vocabulary List* – Hanban
2. *HSK 1 & 2 Workbook and Listening Audio* – BLCU Press
3. *Online Resources: HSKPractice.com*, Du Chinese, Chairman's Bao

ARAB-5109 **Arabic Language** **2(2-0)**
اللغة العربية

This course is designed to develop students' oral proficiency in Arabic, enabling them to communicate confidently and effectively in diverse real-life contexts. Emphasis is placed on enhancing fluency, clarity, and appropriateness in spoken Arabic across both social and academic situations. Students will engage in activities focused on active listening, appropriate responses, asking and answering questions, expressing ideas and opinions, and understanding cultural nuances in communication.

The course incorporates a range of communicative strategies, including role-playing, pair and group discussions, the use of situational dialogues, and interactive speaking exercises. Attention will also be given to vocabulary enrichment, accurate pronunciation, proper intonation, and nonverbal communication. By the end of the course, students are expected to demonstrate improved conversational competence and increased confidence in spoken Arabic.

Contents:

محتويات المقرر:

1. التحية والتعارف، الأسرة.
2. الحياة اليومية، الطعام والشراب.
3. الصلواة.، الدراسة، العمل.
4. حوار بين طالبين، وفي الصف.
5. عند الطبيب، في المستشفى.
6. في المطعم، في دكان الفواكه، في دكان الخضروات.
7. الفصل الدراسي، والطريق.
8. في السوق.

Suggested Readings:

القراءات المقترحة:

1- حاضر اللغة العربية ومستقبلها، لعلاء الجبالى رنا سبلينى دار المشرق، بيروت ،2022م.
2- تاريخ اللغة العربية، أحمد مختار عمر، القاهرة، 2003م.

Recommended Texts:

الكتب الرئيسية:

1- كتاب المحادثة والتعبير 1، للأستاذ الدكتور محمد سليم إسماعيل، والدكتور حبيب الله خان، والدكتور شمس الدين.

ECON-5118 **Mathematical Economics** **2(2+0)**

The course is intended for students who are wishing to obtain knowledge of mathematical techniques suitable for economic analysis. It assumes very little prerequisite knowledge. The approach is informal and aims to show students how to do and apply the mathematics practically. Economic applications are considered although this course aims to teach the mathematics rather than the economics. Topics include basic algebra, simple finance, calculus and matrix algebra.

Contents

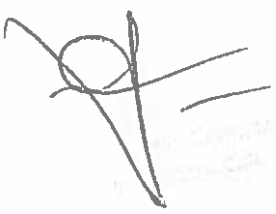
1 Economic Applications of Graphs and Equations: Isocost Lines, Supply and Demand Analysis
2 Income Determination Models, IS-LM Analysis
3 Uses of the Derivative in Mathematics and Economics: Increasing and Decreasing Functions
4 Concavity and Convexity
5 Relative Extrema, Inflection Points, Optimization of Functions
6 Successive-Derivative Test for Optimization, Marginal Concepts
7 Optimizing Economic Functions, Relationship among Total
8 Marginal, and Average Concepts
9 Calculus of Multivariable Functions in Economics: Marginal Productivity
10 Income Determination, Multipliers and Comparative Statics
11 Income and Cross Price Elasticities of Demand, Differentials and Incremental Changes
12 Optimization of Multivariable Functions in Economics
13 Constrained Optimization of Multivariable Functions in Economics
14 Homogeneous Production Functions, Returns to Scale
15 Optimization of Cobb-Douglas Production Functions
16 Optimization of Constant Elasticity of Substitution Production Functions

Recommended Texts

1. Dowling, E.T. (2001). *Introduction to mathematical economists, Schaum's Outline Series* (3rd ed.). New York: McGraw Hill Publishing Company.
2. Weber, E.J. (1976). *Mathematical analysis, business and economic application* (latest ed.). New York: Harper and Row Publishers.

Suggested Readings

1. Chiang, A.C. and Wainwright, K. (2005). *Fundamental methods of mathematical economics* (4th ed.). New York: McGraw Hill Publishing Company.
2. Frank, B.N. (1993). *Applied mathematics for business, economic and social sciences* (4th ed.). New York: McGraw Hill Publishing Company.



EDUC-5110 **Teaching Mathematics** **2(2-0)**

This course focuses on the principles, methods, and strategies for effectively teaching mathematics at various educational levels. It covers lesson planning, use of teaching aids, assessment techniques, and approaches to make math engaging and understandable. Emphasis is placed on problem-solving, conceptual understanding, and adapting instruction to diverse learners.

Contents

Unit 1: Aims and Objectives of Teaching Mathematics

1. Definition and Meanings of mathematics
2. Brief history of Mathematics
3. Mathematics in relation with other subjects
4. Need and importance of teaching of mathematics

Unit 2: Methods of Teaching Mathematics

5. Inductive and Deductive Method
6. Dogmatic and Lecture
7. Analytic and Synthetic Method
8. Heuristic and Project Method
9. Problem Solving Method

Unit 3: Measuring Achievements in Mathematics

10. Assessment, Testing and Evaluation
11. Types of Assessment, tests and Evaluation
12. Preparation of different type of tests in Mathematics

Unit 4: Planning Mathematics Learning

13. Lesson planning.
14. Qualities of good lesson plan.
15. Development of model lesson plans.

Recommended Text:

1. Fauvel, J., & Jeremy G., (2016). *The History of Mathematics:* A Reader: London: Macmillan Press Ltd

Suggested Readings:

1. Muthukumar, V. (2015*). Teaching of Science.* Bharathidasan University, Tiruchirapplli. Retrieved from https://www.pdfdrive.com/
2. Jourdain, P. E. (2018). *The Nature of Mathematics*. Courier Corporation

INTR-5101 **Introduction to International Relations** **2(2-0)**

This course provides a comprehensive introduction to international relations, focusing in particular on its origins and historical evolution, its key concepts, major theoretical frameworks, main actors and institutions, the global architecture of power, and its dynamic nature in the process of globalization. More specifically, the course introduces concepts of power, statecraft, diplomacy, foreign policy, political economy and international security, and examines the evolution of international relations as a subject.

Contents

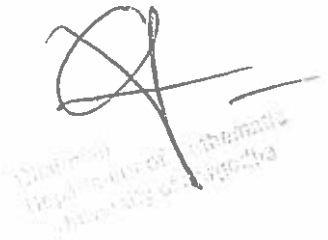
1. IR as an academic field
2. Realism, Liberalism, Marxism
3. Relevance to Current Issues
4. US, Russia and Rise of China
5. Development of the International System
6. History of state development (City State to Empires)
7. Westphalia and Emergence of State system
8. Industrial revolution and French Revolution
9. World War I & World War II
10. Cold War and Post-Cold War
11. States and Other Actors
12. Sovereignty and Nationalism
13. Globalization
14. Foreign Policy

Recommended Texts:

1. Devetak, R. (2011). *An Introduction to International Relations*. Cambridge University Press.
2. Baylis, J., Smith, S. & Owens, P. (2004). *The globalization of World Politics: An Introduction to International Relations*. Oxford University Press.

Suggested Readings:

1. Jackson, R., George, S. (2016). *An Introduction to International Relations: Theories and Approaches* Oxford University Press.
2. Calvocoressi, P. (2008). *World Politics since 1945*. Routledge.



List of Single Major Courses

MATH-5101 **Calculus-I** **3 (3-0)**

Calculus is the mathematical study of continuous change. If quantities are continually changing, we need calculus to study what is going on. Calculus is concerned with comparing quantities which vary in a non-linear way. It is used extensively in science & engineering, since many of the things we are studying (like velocity, acceleration, current in a circuit) do not behave in a simple, linear fashion. Calculus has two major branches, differential calculus (Calculus-I) & integral calculus (Calculus-II); the former concerns instantaneous rates of change, & the slopes of curves, while integral calculus concerns accumulation of quantities, & areas under or between curves. This is the first course of the sequence, Calculus-I, II & III, serving as the foundation of advanced subjects in all areas of mathematics. The sequence, equally, emphasizes basic concepts & skills needed for mathematical manipulation. It focuses on the study of functions of a single variable. Calculus-I is an introduction to differential & integral calculus: the study of change.

Contents

1 Functions: Functions & their graphs, combining functions, Shifting and Scaling Graphs, Trigonometric functions, Exponential function, Inverse function and logarithmic, Rates of change & tangents to curves.
2 Limit and Continuity: Limit of a function & limit laws, the precise definition of a limit One-sided limits, continuity, Limits involving infinity; asymptotes of graphs
3 Derivatives: tangents Lines & derivative at a point, the derivative as a function Differentiation rules, the derivative as a rate of change, Derivatives of trigonometric functions, Chain rule, implicit differentiation, Derivative of inverse functions and logarithms, inverse trigonometric functions. Related rates, linearization & differentials, higher derivatives
4 Applications of derivatives: extreme values of functions, Rolls' theorem, the mean value theorem, Monotonic functions & the first derivative test, Convexity, point of inflection & second derivative test, Concavity & curve sketching, Indeterminate forms & L'Hôpital's rule, Applied optimization, Antiderivatives,
5 Integrals: area & estimating with finite sums, sigma notation & limits of finite sums, definite integral, the fundamental theorem of calculus, Indefinite integrals & the definite integral and the substitution and area between curves

Recommended Texts

1. Thomas, G.B., Weir, M. D., & Hass J. R. (2014). *Thomas' calculus: single variable* (13th ed./Latest). London: Pearson.
2. Stewart, J. (2015).*Calculus* (8th ed. /Latest). Boston: Cengage Learning.

Suggested Readings

1. Anton, H., Bivens I. C., & Davis, S. (2016). *Calculus* (11th ed. /Latest). New York: Wiley.
2. Goldstein, L. J., Lay, D. C., Schneider, D. I.,& Asmar, N. H. (2017).*Calculus & its applications*(14th ed.). London: Pearson.
3. Larson, R., & Edwards, B. H. (2013). *Calculus* (10th ed. /Latest). New York: Brooks Cole.

MATH-5102 **Calculus-II** **3(3-0)**

This is the second course of the basic sequence Calculus serving as the foundation of advanced subjects in all areas of mathematics. The sequence, equally, emphasizes basic concepts & skills needed for mathematical manipulation. As continuation of Calculus-I, it focuses on the study of functions of a single variable. This Core Curriculum course is designed to meet the following four learning goals: Students will construct and evaluate logical arguments. Students will apply and adapt a variety of appropriate strategies to solve mathematical problems. Students will recognize and apply mathematics in contexts outside of mathematics. Students will organize and consolidate mathematical thinking through written and oral communication. Students will integrate transcendental functions, including logarithms, exponential, trigonometry and inverse trigonometric, hyperbolic and inverse hyperbolic functions, apply methods of integration, such as algebraic substitution, trigonometric substitution, partial fractions, integration by parts, and use a table of integrals, solve limit problems involving indeterminate forms with La'Hopital's Rule and convert parametric representation of curves to rectangular coordinates, represent a curve using polar coordinates, and integrate functions expressed in polar coordinates.

Contents

1 Applications of definite integrals: volumes using cross-sections, Volumes using cylindrical shells, arc length, Areas of surfaces of revolution
2 Transcendental functions: Inverse functions & their derivatives, Natural logarithms, exponential functions, Inverse trigonometric functions, hyperbolic functions, related rates of Growth.
3 Techniques of integration:
Using Basic Integration Formulas, Integration by Parts, Trigonometric Integrals, Trigonometric Substitutions, Integration of Rational Functions by Partial Fractions,Integral Tables & Computer Algebra Systems, Numerical Integration, Improper Integrals
4 Infinite Sequences and Series:
Sequences, Infinite Series, The Integral Test, Comparison Tests, Absolute Convergence, The Ratio & Root Tests, Alternating Series & Conditional Convergence, Power Series, Taylor & Maclaurin Series, Convergence of Taylor Series, The Binomial Series & Applications of Taylor Series
5 Parametric equations and Polar Coordinates:
Parametrizations of Plane Curves, Calculus with Parametric Curves, Polar Coordinates, Graphing Polar Coordinate Equations, Areas & Lengths in Polar Coordinates, Conic Sections, Conics in Polar Coordinates.

Pre-requisite: Calculus-I

Recommended Texts

1 Thomas, G. B., Weir, M. D., & Hass, J. R. (2014). *Thomas' calculus: single variable* (13th ed. /Latest). London: Pearson.
2 Stewart, J. (2012). *Calculus*, (8th ed. /Latest). New York: Cengage Learning.

Suggested Readings

1 Anton, H., Bivens, I. C., & Davis, S. (2016). *Calculus*, (11th ed. /Latest). New York: Wiley.
2 Goldstein, L. J., Lay, D. C., Schneider, D. I., & Asmar, N. H. (2017). *Calculus &its applications* (14th ed.). London: Pearson.
3 Larson, R., & Edwards, B. H. (2013). *Calculus* (10th ed. /Latest). New York: Brooks Cole.

MATH-5103 **Discrete Mathematics** **3(3+0)**

This is an introductory course in discrete mathematics. Discrete Mathematics is study of distinct, un-related topics of mathematics; it embraces topics from early stages of mathematical development & recent additions to the discipline as well. It is the study of mathematical structures that are fundamentally discrete rather than continuous. In contrast to real numbers that have the property of varying "smoothly", the objects studied in discrete mathematics, such as integers, graphs, & statements in logic. The goal of this course is to introduce students to ideas and techniques from discrete mathematics that are widely used in science and engineering. This course teaches the students techniques in how to think logically and mathematically and apply these techniques in solving problems. To achieve this goal, students will learn logic and proof, sets, functions, as well as algorithms and mathematical reasoning. Key topics involving relations, graphs, trees, and formal languages and computability are covered in this course. The present course restricts only to counting methods, relations & graphs. The objective of the course is to inculcate in the students the skills that are necessary for decision making in non-continuous situations.

Contents

1 Counting methods: Basic methods: product
2 Inclusion-exclusion formulae
3 Mathematical Induction
4 Permutations & combinations
5 Recurrence relations & their solutions
6 Generating functions
7 Double counting & its applications
8 Pigeonhole principle & its applications
9 Relations: Binary relations, n-ary Relations, closures of relations
10 Composition of relations, inverse relation
11 Graphs: Graph terminology
12 Representation of graphs
13 Graphs isomorphism
14 Algebraic methods: the incidence matrix, connectivity
15 Eulerian & Hamiltonian paths, shortest path problem
16 Trees & spanning trees, Complete graphs & bivalent graphs

Recommended Texts

1. Rosen, K.H. (2012). *Discrete mathematics & its applications.* New York: The McGraw-Hill Companies, Inc.
2. Chartr, G., & Zhang, P. (2012). *A first course in graph theory.* New York: Dover Publications, Inc.

Suggested Readings

1. Tucker, A. (2002). *Applied combinatorics.* New York: John Wiley & Sons.
2. Diestel, R. (2010). *Graph theory* (4th ed.). New York: Springer- Verlag
3. Brigs, N. L. (2003). *Discrete mathematics.* Oxford: Oxford University Press.

MATH-5104 **Calculus-III** **3(3-0)**

This is the third course of the basic sequence Calculus-I, II & III, serving as the foundation of advanced subjects in all areas of mathematics. It focuses on the study of functions of a multivariable. The main focus of the course is to the study of multiple integrals in different coordinate systems & their applications. Moreover, a brief introduction to vector calculus will also be presented.

Contents

1 Vectors and the geometry of space:
Three-dimensional Coordinate System, Vectors, The dot product, The cross product, Lines & planes in space, Cylinder & Quadric surfaces,

2 Vector valued functions and Motion in space:
Curves in space and their tangents, Derivatives & integrals of vector functions, Arc length & Curvature, Motion in space, Velocity & Acceleration, Tangential & Normal Components of Acceleration, Velocity & Acceleration in Polar Coordinates

3 Functions of several variables: limits, Continuity & partial derivatives, The Chain rule, directional derivatives & the gradient vector, Maximum & minimum values, optimization problems, Lagrange Multipliers

4 Multiple integrals: Double integrals over rectangles & iterated integrals, Double integrals over general regions, Double integrals in polar coordinates, Triple integrals in rectangular, cylindrical & spherical coordinates, Applications of double & triple integrals, Change of variables in multiple integrals

5 Vector calculus: Vector fields, line integrals, The fundamental theorem of Line Integrals
Green's theorem, Curl & divergence, Surface integrals over scalar & vector fields
Divergence theorem, Stokes' theorem

Pre-requisite: Calculus-II

Recommended Texts

1. Thomas, G. B., Weir, M.D., & Hass J.R. (2014). *Thomas' Calculus: multivariable* (13th ed. /Latest). London: Pearson.
2. Stewart, J. (2015). *Calculus* (8th ed. /Latest). New York: Cengage Learning.

Suggested Readings

1. Anton, H., Bivens, I. C., & Davis, S. (2016). *Calculus* (11th ed. /Latest). New York: Wiley.
2. Goldstein, L. J., Lay, D. C., Schneider, D. I., & Asmar, N. H. (2017). *Calculus & its applications* (14th ed. /Latest). London: Pearson.
3. Larson, R., & Edwards, B. H. (2013). *Calculus* (10th ed. /Latest). New York: Brooks Cole.

MATH-5105 **Abstract Algebra** **3(3-0)**

This course is an introduction to group theory, one of the three main branches of pure mathematics. Group theory is the study of groups. Group theory is one of the great simplifying and unifying ideas in modern mathematics. It was introduced in order to understand the solutions to polynomial equations, but only in the last one hundred years has its full significance, as a mathematical formulation of symmetry, been understood. It plays a role in our understanding of fundamental particles, the structure of crystal lattices and the geometry of molecules. In this course, we will begin by defining the axioms satisfied by groups and begin to develop basic group theory by reference to some elementary examples. We will analyze the structure of 'small' finite groups, and examine examples arising as groups of permutations of a set, symmetries of regular polygons and regular solids, and groups of matrices. We will develop the notions of homomorphism, normal subgroups and quotient groups and study the First Isomorphism Theorem and its application.

Contents

1 Groups, definition & examples of groups, elementary properties of groups
2 Finite & Infinite Groups, Order of element of a group & related results
3 Subgroups, examples of subgroup, subgroup tests, subgroup generated by set
4 Cyclic groups, properties of cyclic groups
5 Classification of subgroups of cyclic groups
6 Cosets decomposition of a group, properties of cosets
7 Conjugate elements & conjugacy classes, Lagrange's theorem & its consequences
8 Centralizer of a subset of a group, normalizer of a subset of a group
9 Center of group definition & examples
10 Normal Subgroups, factor groups, application of factor groups
11 Permutations & Permutation groups, definition & examples
12 Homomorphism of groups, properties of Homomorphisms
13 Fundamental theorem of homomorphism
14 Isomorphism theorems, properties of Isomorphisms & Cayley's theorem
15 Endomorphism & automorphisms of groups, Commutator subgroups
16 External & Internal direct products, definition & examples
17 Rings: Definition, examples
18 Examples of non-commutative rings, Polynomial rings
19 Matrix rings. Units, zero-divisors
20 Nilpotent, idempotents. Subrings, Ideals, Maximal & prime Ideals.

Recommended Texts

1. Gallian, J.A. (2017). *Contemporary abstract algebra* (9th ed.). New York: Brooks/Cole.
2. Malik, D. S., Mordeson, J. N. & Sen, M.K. (1997). *Fundamentals of abstract algebra*. New York: WCB/McGraw-Hill.

Suggested Readings

1. Roman, S. (2012). *Fundamentals of group theory* (1st ed.). Basel: Birkhäuser.
2. Rose, H. E. (2006). *A course on finite groups* (1st ed.). London: Springer-Verlag.
3. Fraleigh, J.B. (2003). A *first course in abstract algebra* (7th ed.). Boston: Addison-Wesley Publishing Company.

MATH-5106 **Vector & Tensor Analysis** **3 (3-0)**

This course is designed primarily for those students taking courses in mathematics. Vector and tensor algebra have in recent years become basic part of fundamental mathematical background required of those in engineering, sciences and allied disciplines. It is said that vector and tensor analysis is a natural aid in forming mental pictures of physical and geometrical ideas. A most rewarding language and mode of thought for the physical sciences. The focus, therefore, is to impart useful skills on the students in order to enhance their Mathematical ability in applying vector technique to solve problems in applied sciences and to equip them with necessary skill required to cope with higher levels courses in related subjects. Topics to be covered in this course include, basic vector 2 algebra, coordinate bases, gradient, divergence, and curl, Green's, Gauss' and Stokes' theorems. The metric tensor, Christoffel symbols and Riemann curvature tensor. Applications will be drawn from differential geometry, continuum mechanics, electromagnetism, general relativity theory.

Contents

1 Vector Analysis: Scalar triple product with applications
2 Vector triple product with applications
3 Gradient of a scalar function
4 Divergence of vector functions
5 Curl of vector functions
6 Application of the del operator
7 Curvilinear coordinates
8 Coordinates surfaces
9 Cartesian Tensors: Summation convention
10 Transformation equations
11 Orthogonally conditions
12 Kronecker delta & Levi-civita symbol
13 Tensors of different ranks
14 Symmetric & anti symmetric tensors
15 Related theorems
16 Application to Vector Analysis

Recommended Texts

1. Shah, N.A. (2015). *Vector & tenser analysis*. Lahore: Ilmi Ketab Khana.
2. Spiegel, M.R. (2016). *Vector & Introduction to tensor analysis*. New York: McGraw Hill.
3. Yousuf, S.M. (1988). *Elementary Vector analysis*. Lahore: Ilmi Ketab Khana.

Suggested Readings

1. Young, E.C. (1993). *Vector & tensor analysis*. New York: Marcel Dekker, Inc.
2. Brand, L. (2006). *Vector analysis*, New York: Dover Publications.

MATH-5107 **Linear Algebra** **3(3-0)**

Linear algebra is the study of linear systems of equations, vector spaces, and linear transformations. Solving systems of linear equations is a basic tool of many mathematical procedures used for solving problems in science and engineering. Linear Algebra plays a significant role in many areas of mathematics, statistics, engineering, the natural sciences, and the computer sciences. It provides a foundation of important mathematical ideas that will help students be successful in future coursework. The main objective of this course is to help students to learn in rigorous manner, the tools & methods essential for studying the solution spaces of problems in mathematics and in other fields& develop mathematical skills needed to apply these to the problems arising within their field of study and to various real-world problems. The student will become competent in solving linear equations, performing matrix algebra, calculating determinants, finding eigenvalues & eigenvectors and the student will come to understand a matrix as a linear transformation relative to a basis of a vector space.

Contents

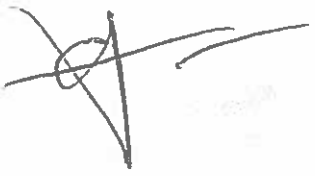
1 Representation of linear equations in matrix form
2 Solution of linear system, Gauss-Jordan & Gaussian elimination method
3 Vector space, definition, examples & properties
4 Subspaces, Linear combination & spanning set
5 Linearly Dependent & Linearly Independent sets
6 Bases & dimension of a vector space
7 Intersections, sums & direct sums of subspaces, Quotient Spaces, Change of basis
8 Linear transformation, Rank & Nullity of linear transformation
9 Matrix of linear transformations
10 Eigen values & eigen vectors, Dual spaces
11 Inner product Spaces with properties, Projection
12 Cauchy inequality
13 Orthogonal & orthonormal basis
14 Gram Schmidt process & diagonalization

Recommended Texts

1. Dar, K.H. (2007). *Linear algebra* (1st ed.). Karachi: The Carwan Book House.
2. Kolman, B.,& Hill, D. R. (2005). *Introductory linear algebra* (8th ed.). London: Pearson/Prentice Hall.

Suggested Readings

1. Cherney, D., Denton, T., Thomas, R., & Waldron, A. (2013). *Linear algebra* (1st ed.). California: Davis.
2. Anton, H., & Rorres, C. (2014). *Elementary linear algebra: applications version* (11th ed.). New York: John Wiley & Sons.
3. Grossman, S. I. (2004). *Elementary linear algebra* (5th ed.). New York: Cengage Learning.



MATH-5108 **Fundamental of Mechanics** **3(3-0)**

This course shall assume background in calculus. This course introduces the fundamental principles in mechanics. Structural design applications of a variety of problems are developed throughout the course using examples that elucidate the theory of mechanics. It emphasizes on the laws of friction, equilibrium, center of gravity & harmonic & orbital motion. The objectives of the course are to develop better understanding of key concepts concerning scalar and vector fields learned previously in Multivariable Calculus courses, to gain deeper knowledge of multivariate differentiation operations such as Gradient, Divergent and Curl, master the Integral Theorems at the core of Vector Analysis: the Stokes (Greens') Theorem and the Divergence (Gauss') Theorem and to learn the utility of Vector Analysis by learning its relevance to Maxwell's equations describing the dynamics of electric and magnetic fields. In this course, students are prepared for further study in the relevant technological disciplines and more advanced mathematics courses.

Contents

1 Mechanics: Composition & resolution of co-planar forces, Moments
2 Couples & conditions of equilibrium under the action of co-planar forces
3 Frictional forces, Laws of friction
4 Equilibrium of bodies on rough surfaces
5 Principle of virtual work & related problems
6 Center of gravity, Center of mass of various bodies
7 Kinematics of a particle in Cartesian & polar co-ordinates
8 Linear & angular velocity
9 Rectilinear motion with uniform & variable acceleration
10 Simple harmonic motion
11 Projectile motion

Recommended Texts

1. Munawar, H., Saeed, S.M., & Ahmed, C.B. (2016). *Elementary vector analysis.* Lahore: The Caravan Book House.
2. Ghori, Q.K. (2015). *Mechanics.* West Pakistan Publishing Company, Lahore:

Suggested Readings

1. Spiegel, M. R., Lipschutz, S., & Spellman, D. (2009). *Schaum's outline vector analysis* (2nd ed.). New York: McGraw-Hill Education.
2. Brand, L. (2006). *Vector analysis.* New York: Dover Publications.
3. Yousuf, S.M. (1988). *Vector analysis.* Lahore: Ilmi Ketab Khana.

MATH-5109 **Number Theory** **3(3-0)**

Number theory (or arithmetic or higher arithmetic in older usage) is a branch of pure mathematics devoted primarily to the study of the integers & integer-valued functions. Integers can be considered either in themselves or as solutions to equations (Diophantine geometry). There are two subfields of number theory. One is Analytical Number Theory and other is Algebraic number theory. The focus of the course is on study of the fundamental properties of integers & develops ability to prove basic theorems. The specific objectives include study of division algorithm, prime numbers & their distributions, Diophantine equations & the theory of congruences. Students will learn about the arithmetic of algebraic number fields. They will learn to prove theorems about integral bases, & about unique factorization into ideals. They will learn to calculate class numbers, & to use the theory to solve simple Diophantine equations.

Contents

1 Divisibility
2 Euclid's theorem
3 Linear Diophantine Equation
4 Greatest common divisor and least common multiple
5 Congruences, Elementary properties
6 Residue classes & Euler's function
7 Linear congruence & congruence of higher degree
8 The theorems of Fermat
9 Euler & Wilson theorem
10 Cryptology, character Ciphers
11 Primitive roots & indices
12 Integers belonging to a given exponent
13 Quadratic Residues
14 Legendre symbol
15 Law of quadratic reciprocity, The Jacobi symbol
16 Number-Theoretic Functions
17 Mobius function

Recommended Texts

1. Rosen, K.H. (2000). *Elementary number theory & its applications*. (4th ed.). Boston: Addison-Wesley.
2. Apostal, T.M. (2010). *Introduction to analytic number theory* (3rd ed.). New York: Springer.

Suggested Readings

1. Leveque, W.J. (2002). *Topics in number theory*, Volumes I & II. New York: Dover Books.
2. Burton, D.M. (2007). *Elementary number theory*. New York: McGraw-Hill.

MATH-5110 **Ordinary Differential Equations** 3(3-0)

This course introduces the theory, solution, & application of ordinary differential equations. Topics discussed in the course include methods of solving first-order differential equations, existence & uniqueness theorems, second-order linear equations, power series solutions, higher-order linear equations, systems of equations, non-linear equations, Sturm-Liouville theory, & applications. The relationship between differential equations & linear algebra is emphasized in this course. An introduction to numerical solutions is also provided. Applications of differential equations in physics, engineering, biology, & economics are presented. The goal of this course is to provide the student with an understanding of the solutions & applications of ordinary differential equations. The course serves as an introduction to both nonlinear differential equations & provides a prerequisite for further study in those areas.

Contents

1 Introduction to differential equations: Preliminaries & classification of differential equations
2 Verification of solution, existence of unique solutions, introduction to initial value problems
3 Basic concepts, formation & solution of first order ordinary differential equations
4 Separable equations, linear equations, integrating factors, Exact Equations
5 Solution of nonlinear first order differential equations by substitution, Homogeneous Equations,
6 Bernoulli equation, Ricaati's equation & Clairaut equation
7 Modeling with first-order ODEs: Linear models, Nonlinear models
8 Initial value & boundary value problems
9 Homogeneous & non-homogeneous linear higher order ODEs & their solutions, Wronskian,
10 Reduction of order, homogeneous equations with constant coefficients,
11 Nonhomogeneous equations, undetermined coefficients method, Superposition principle
12 Annihilator approach, variation of parameters, Cauchy-Euler equation,
13 Solving system of linear differential equations by elimination
14 Solution of nonlinear differential equations

Recommended Texts

1 Boyce, W. E., & Diprima, R. C. (2012). *Elementary differential equations & boundary value problems* (10th ed.) USA: John Wiley & Sons.
2 Zill, D.G., & Michael, R. (2009) *Differential equations with boundary-value problems* (5th ed.) New York: Brooks/Cole.

Suggested Readings

1 Arnold, V. I. (1991). *Ordinary differential equations* (3rd ed.). New York: Springer.
2 Apostol, T. (1969). *Multi variable calculus &linear algebra* (2nd ed.). New York: John Wiley & sons.

MATH-6101 **Real Analysis –I** **3(3-0)**

This is the first part of a two-semester course. This course covers the fundamentals of mathematical analysis: convergence of sequences & series, continuity, differentiability, Riemann integral, sequences & series of functions, uniformity, & the interchange of limit operations. It shows the utility of abstract concepts & teaches an understanding & construction of proofs. It develops the fundamental ideas of analysis & is aimed at developing the student's ability to describe the real line as a complete, ordered field, to use the definitions of convergence as they apply to sequences, series, & functions, to determine the continuity, differentiability & integrability of functions defined on subsets of the real line, to write solutions to problems & proofs of theorems that meet rigorous standards based on content, organization & coherence, argument & support, & style & mechanics, to determine the Riemann integrability of a bounded function & prove a selection of theorems concerning integration, to recognize the difference between point wise & uniform convergence of a sequence of functions & to illustrate the effect of uniform convergence on the limit function with respect to continuity.

Contents

1 Number Systems: Ordered fields
2 rational, real & complex numbers
3 Archimedean property
4 supremum, infimum & completeness
5 Topology of real numbers
6 Convergence, completeness, completion of real numbers
7 Heine Borel theorem
8 Sequences & Series of Real Numbers
9 Limits of sequences, algebra of limits
10 Bolzano Weierstrass theorem, Cauchy sequences, liminf, limsup
11 limits of series, convergences tests, absolute & conditional convergence, power series
12 Continuity: Functions, continuity & compactness, existence of minimizers & maximizers
13 uniform continuity, continuity & connectedness, intermediate mean value theorem
14 monotone functions & discontinuities

Recommended Texts

1. Bartle, R. G.,& Sherbert, D. R. (2011). *Introduction to real analysis* (4th ed.) New York: John Wiley & Sons.
2. Trench, W. F. (2013). *Introduction to real analysis* (2nd ed.). New Jersey: Prentice Hall.

Suggested Readings

1. Folland, G.B. (1999). *Real analysis* (2nd ed.). New York: John Wiley & Sons.
2. Rudin, W. (1976). *Principles of mathematical analysis* (3rd ed.) New York: McGraw-Hill.
3. Royden, H., &Fitzpatrick, P. (2010). *Real analysis* (4th ed.). New Jersey: Pearson Hall.

MATH-6102 **Topology** **3(3-0)**

Topology studies continuity in its broadest context. We begin by analyzing the notion of continuity familiar from calculus, showing that it depends on being able to measure distance in Euclidean space. This leads to the more general notion of a metric space. A brief investigation of metric spaces shows that they do not provide the most suitable context for studying continuity. A deeper analysis of continuity in metric spaces shows that only the open sets matter, which leads to the notion of topological spaces. We easily see that this is the right setting for studying continuity. The central concepts of topology, compactness, connectedness & separation axioms are introduced. Applications of topology to number theory, algebraic geometry, algebra & functional analysis are featured. Since many important applications of topology use metric spaces, we investigate topological concepts applied to them & introduce the notion of completeness. In addition, this course provides the basis for studying differential geometry, functional analysis, classical & quantum mechanics, dynamical systems, algebraic & differential topology.

Contents

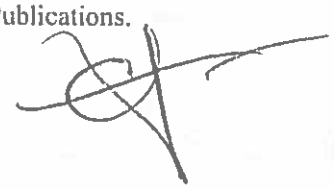
1 Topological spaces
2 Bases & sub-bases
3 First & second axiom of countability
4 Separability
5 Continuous functions & homeomorphism
6 Finite product space
7 Separation axioms (T_0)
8 Separation axioms (T_1)
9 Separation axioms (T_2)
10 Techonoff spaces
11 Regular spaces
12 Completely regular spaces
13 Normal spaces
14 Product spaces
15 Compactness
16 Connectedness

Recommended Texts

1. Sheldon, W. D.(2005). *Topology* (1st ed.). New York: McGraw Hill.
2. Willard, S. (2004). *General topology* (1st ed.). New York: Dover Publications.

Suggested Readings

1. Lipschutz, S. (2011). *General topology, Schaum's outline series* (1st ed.). New York: McGraw Hill.
2. Armstrong, M.A. (1979). *Basic topology* (1st ed.). New York: McGraw Hill.
3. Mendelson, B. (2009). *Introduction to topology* (3rd ed.). New York: Dover Publications.



MATH-6103 **Partial Differential Equations** **3(3-0)**

Partial Differential Equations (PDEs) are in the heart of applied mathematics & many other scientific disciplines. The beginning weeks of the course aim to develop enough familiarity & experience with the basic phenomena, approaches, & methods in solving initial/boundary value problems in the contexts of the classical prototype linear PDEs of constant coefficients: the Laplace equation, the wave equation & the heat equation. A variety of tools & methods, such as Fourier series/eigen function expansions, Fourier transforms, energy methods, & maximum principles will be introduced. More importantly, appropriate methods are introduced for the purpose of establishing quantitative as well as qualitative characteristic properties of solutions to each class of equations

Contents

1 First order PDEs: Introduction, Formation of PDEs, Solutions of PDEs of first order
2 The Cauchy's problem for quasi linear first order PDEs, First order nonlinear equations
3 Special types of first order equations Second order PDEs
4 Basic concepts & definitions, Mathematical problems, Linear operator
5 Superposition, Mathematical models
6 The classical equations, The vibrating string, The vibrating membrane
7 Conduction of heat solids, Canonical forms & variable
8 PDEs of second order in two independent variables with constant & variable coefficients
9 Cauchy's problem for second order PDEs in two independent variables
10 Methods of separation of variables, Solutions of elliptic
11 Laplace transform: Introduction & properties of Laplace transform
12 Transforms of elementary functions, Periodic functions, error functions
13 Dirac delta function, Inverse Laplace transform, Convolution Theorem
14 Solution of PDEs by Laplace transform, Diffusion & wave equations
15 Fourier transforms, Fourier integral representation
16 Fourier sine & cosine representation, Fourier transform pair
17 Transform of elementary functions & Dirac delta function, Finite Fourier transforms
18 Solutions of heat, Wave & Laplace equations by Fourier transforms

Recommended Texts

1 Myint U. T. Partial Differential Equations for Scientists and Engineers, (3rd ed.). North Holland, Amsterdam, 1987
2 Zill, D.G., & Michael, R. (2009). *Differential equations with boundary-value problems* (5th ed.) New York: Brooks/Cole.
3 Polking, J., & Boggess, A. (2005). *Differential equations with boundary value problems* (2nd ed.). London: Pearson.

Suggested Readings

1 Wloka, J. (1987). *Partial differential equations* (1st ed.). Cambridge: Cambridge University Press.
2 Humi, M., & Miller, W. B. (1991). *Boundary value problems &partial differential equations* (1st ed.). Boston: PWS- KENT Publishing Company.

MATH-6104 **Numerical Analysis-I** **3(3+0)**

To explore complex systems, physicists, engineers, financiers and mathematicians require computational methods since mathematical models are only rarely solvable algebraically. Numerical methods, based upon sound computational mathematics, are the basic algorithms underpinning computer predictions in modern systems science. The course will cover the classical fundamental topics in numerical methods such as, approximation, numerical linear algebra, solution of nonlinear algebraic systems, matrix decomposition, interpolation and unstable systems. The viewpoint will be modern, with connections made between each topic and a variety of applications. It is optimal to verify numerical methods by using computer programming (Mat Lab, Maple, C++, etc.)

Contents

1 Error analysis: Floating point arithmetic, Error Approximations
2 Methods for the solution of non-linear equations: Bisection method, Regula-Falsi method, Fixed point iteration method, Newton-Raphson method, Secant method, Convergence criteria, Muller's Method, Graeffe's root squaring Method. System of non-linear equations.
3 Numerical solutions of a system of linear equations: Direct methods: Gaussian elimination method, Gauss-Jordan method, Pivoting techniques
4 LU-decomposition: Crout's method of factorization, matrix inversion, Cholesky's method and Doolittle's method
5 Iterative methods: Jacobi method, Gauss-Seidel Method, Relaxation Method. Matrix Norm, Condition Number and Ill-conditioned system
6 Eigen values problems: Introduction, Power Method, Jaccobi's Method
7 Interpolation: Finite differences operators, Forward differences and Backward difference operators, shift operator, Average operator, Differential operator, Relation between operators, shift operator, Average operator, Newton's forward Differences interpolation formula, Newton's backward differences interpolation formula, Lagrange's interpolation formula, Newton's Divided difference interpolation formula, Interpolation in two dimensions, Hermite interpolation.

Recommended Texts

1. Burden, R. L., Faires, J. D., & Burden, A.M. (2015). *Numerical analysis* (10th ed.). Boston: Cengage Learning.
2. Gerald, C.F., & Wheatley, P.O. (2005). *Applied numerical analysis*. London: Pearson Education, Singapore.

Suggested Readings

1. Philip, J. (2019). *Numerical applied computational programming with case studies* (1st ed.). *New York:* A press.
2. Khoury, R., & Harder, D.W. (2016). *Numerical methods & modelling for engineering (1st ed.). London:* Springer.
3. Antia, H.M. (2012). *Numerical methods for scientists & engineers* (3rd ed.). New York: Springer.

MATH-6105 **Real Analysis –II** **3(3-0)**

This course is continuation of Real Analysis I, this course will continue to cover the fundamentals of real analysis, concentrating on the Riemann-Stieltjes integrals, Functions of Bounded Variation, Improper Integrals, & convergence of series. Emphasis would be on proofs of main results. The aim of this course is also to provide an accessible, reasonably paced treatment of the basic concepts & techniques of real analysis for students in these areas. This course provides greatly strengthening student's understanding of the results of calculus & the basis for their validity the uses of deductive reasoning, increasing the student's ability to understand definitions, understand proofs, analyze conjectures, find counter-examples to false statements, construct proofs of true statements & enhancing the student's mathematical communication skills.

Contents

1. Differentiation: Mean value theorem, L'Hopital's Rule, Taylor's theorem
2. The Riemann-Stieltjes Integrals
3. Definition & existence of integrals
4. Properties of integrals
5. Fundamental theorem of calculus & its applications
6. Change of variable theorem, integration by parts
7. Functions of Bounded Variation
8. Definition & examples, properties of functions of bounded variation
9. Improper Integrals: Types of improper integrals
10. Tests for convergence of improper integrals
11. Beta & gamma functions
12. Absolute & conditional convergence of improper integrals
13. Sequences & Series of Functions
14. Power series, definition of point wise & uniform convergence
15. Uniform convergence & continuity
16. Uniform convergence & differentiation, examples of uniform convergence

Pre-requisite: Real Analysis-I

Recommended Texts

1 Bartle, R. G., & Sherbert, D. R. (2011). *Introduction to real analysis* (4th ed.). New York: John Wiley & Sons.

2 Rudin, W. (1976). *Principles of mathematical analysis* (3rd ed.). New York: McGraw-Hill.

Suggested Readings

1 Folland, G. B. (1999). *Real analysis* (2nd ed.). New York: John Wiley & Sons.

2 Hewitt, E., & Stromberg, K. (1965). *Real &abstract analysis*. New York: Springer-Verlag Heidelberg

3 Lang, S. (1968). *Analysis I*. Boston: Addison-Wesley Publ. Co.

MATH-6106 **Complex Analysis** **3(3-0)**

This is an introductory course in complex analysis, giving the basics of the theory along with applications, with an emphasis on applications of complex analysis & especially conformal mappings. Students should have a background in real analysis (as in the course Real Analysis I), including the ability to write a simple proof in an analysis context. Complex Analysis is a topic that is extremely useful in many applied topics such as numerical analysis, electrical engineering, physics, chaos theory, & much more, & you will see some of these applications throughout the course. In addition, complex analysis is a subject that is, in a sense, very complete. The concept of complex differentiation is much more restrictive than that of real differentiation & as a result the corresponding theory of complex differentiable functions is a particularly nice one.

Contents

1 Introduction: The algebra of complex numbers
2 Geometric representation of complex numbers
3 Polar form of complex numbers
4 Powers & roots of complex numbers
5 Functions of Complex Variables
6 Limit
7 Continuity
8 Differentiable functions, the Cauchy-Riemann equations
9 Analytic functions, entire functions, harmonic functions
10 Elementary functions: The exponential, Trigonometric functions
11 Hyperbolic, Logarithmic & Inverse elementary functions
12 Complex Integrals: Contours & contour integrals, anti-derivatives, independence of path
13 Cauchy-Goursat theorem, Cauchy integral formula, Lioville's theorem, Morerea's theorem
14 Maximum Modulus Principle
15 Series: Power series, Radius of convergence & analyticity
16 Taylor's & Laurent's series
17 Integration & differentiation of power series, isolated singular points
18 Cauchy's residue theorem with applications
19 Types of singularities & calculus of residues, Zeros & Poles, Mobius transforms
20 Conformal mappings & transformations

Recommended Texts

1 Mathews J. H., & Howell, R.W. (2006). *Complex analysis for mathematics &engineering* (5th ed.). Burlington: Jones & Bartlett Publication.
2 Churchill, R.V., & Brown, J.W. (2013). *Complex variables &applications* (9th ed.). New York: McGraw-Hill.

Suggested Readings

1 Remmert, R. (1998). *Theory of complex functions* (1st ed.). New York: Springer-Verlag.
2 Rudin, W. (1987). *Real &complex analysis* (3rd ed.). New York: McGraw-Hill.

MATH-6107 **Numerical Analysis- II** **3(3+0)**

Numerical analysis is the study of algorithms that use numerical approximation instead of symbolic manipulations for the problems of mathematical analysis. Numerical methods, based upon sound computational mathematics, are the basic algorithms underpinning computer predictions in modern systems science. The course will cover the classical fundamental topics in numerical methods such as, numerical integration, solution of ordinary and partial differential equations. Linear operators, multi-step methods and solution of difference equations of different types. The viewpoint will be modern, with connections made between each topic and a variety of applications.

Contents

1 Numerical differentiation and Numerical Integration: Numerical Differentiation: Introduction, Differentiation using difference operators, Differentiation using interpolation
2 Numerical Integration: Newton-Cotes integration formulae, Composite Integration, Rectangular rule, Trapezoidal rule (simple and composite), Simpson's 1/3 rule and Simpson's 3/8 rule of integration
3 Boole's rule & Weddle's rules, Basic technique of finding error term
4 Numerical Solution of ODE: Introduction, Initial Value Problem, Boundary Value Problem, Taylor's Series method, Euler method, modified Euler's method, Instability criteria of Euler method, Runge-Kutta methods for solving initial value problems
5 Multi step methods: Predictor-Corrector method, Milne's methods, Adam Bash-forth methods
6 Difference Equations: Introduction to numerical solutions, Formulation of difference equations, Solution of linear/non-linear difference equations with constant coefficients, Solution of homogeneous difference equations with constant coefficients, Solution of inhomogeneous difference equations with constant coefficients

Pre-requisite: Numerical Analysis-I

Recommended Texts

1. Burden, R. L., Faires, J. D., & Burden, A.M. (2015). *Numerical analysis* (10th ed.). Boston: Cengage Learning.
2. Gerald, C. F., & Wheatley, P.O. (2003). *Applied numerical analysis* (7th ed.). London: Pearson.

Suggested Readings

1. Kuo, Shan S. (1972). *Computer applications of numerical methods*. Islamabad: National Book Foundations.
2. Philip, J. (2019). *Numerical applied computational programming with case studies* (1st ed.). New York: A press.
3. Khoury, R., & Harder, D.W. (2016). *Numerical methods & modelling for engineering (1st ed.). London:* Springer.
4. Antia, H.M. (2012). *Numerical methods for scientists & engineers* (3rd ed.). New York: Springer.

MATH-6108 **Mathematical Methods** **3(3-0)**

Mathematical methods present an applied mathematics course designed to provide the necessary analytical and numerical background for courses in astrophysics, plasma physics, fluid dynamics, electromagnetism, and radiation transfer. The main objective of this course is to provide the students with a range of mathematical methods that are essential to the solution of advanced problems encountered in the fields of applied physics & engineering. Calculation-oriented mathematics is included in all topics relevant. Systems of linear equations, Gauss-Jordan-elimination, basic matrix algebra, determinants. Limits and continuity, differentiation and integration of functions in one variable, maxima and minima, implicit differentiation and trigonometric functions, related rates, differentials and linearization, L'Hopitals rule, Newton's method and the bisection method. Riemann sums and the fundamental theorem in calculus, integral functions, definite and indefinite integrals, basic integration techniques, substitution and partial integration, numerical integration by the rectangle and trapezium methods, improper integrals. Area, volume and arc length. Modeling with differential equations, first order separable and linear differential equations, Euler's method, second order linear differential equations with constant coefficients.

Contents

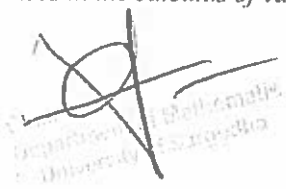
7 Hankel transforms for the solution of PDEs & their application to boundary value problems
8 Green's Functions & Transform Methods: Expansion for Green's functions
9 Sturm-Liouville problems: Introduction to eigen value problem, adjoint & self-adjoint operators,
10 Self-adjoint differential equations, eigen values & eigen functions
11 Sturm-Liouville (S-L) boundary value problems, regular & singular S-L problems
12 Transform methods. Closed form Green's functions. Perturbation Techniques
13 Perturbation methods for algebraic equations
14 Perturbation methods for differential equations
15 Variational Methods: Euler-Lagrange equations
16 Integr & involving one, two, three & n variables
17 Special cases of Euler-Lagrange's equations
18 Necessary conditions for existence of an extremum of a functional
19 Constrained maxima & minima

Recommended Texts

1. Powers, D. L. (2005). *Boundary value problems & partial differential equations* (5th ed.). Boston: Academic Press.
2. Boyce, W.E. (2005). *Elementary differential equations* (8th ed.). New York: John Wiley & Sons.

Suggested Readings

1. Brown, J.W., & Churchil, R.V. (2006). *Fourier series &boundary value problems.* New York: McGraw Hill.
2. Snider, A.D. (2006). *Partial differential equations.* New York: Dover Publications Inc.
3. Boyce, W.E. (2005). *Elementary differential equations* (8th ed.). New York: John Wiley & Sons.
4. Krasnov, M.L., Makarenko, G.I., & Kiselev, A.I. (1985). *Problems &exercises in the calculus of variations.* USA: Imported Publications, Inc.



MATH-6111 **Differential Geometry** **3(3-0)**

Differential geometry is the study of geometric properties of curves, surfaces, & their higher dimensional analogues using the methods of calculus. It has a long & rich history, &, in addition to its intrinsic mathematical value & important connections with various other branches of mathematics, it has many applications in various physical sciences, e.g., solid mechanics, computer tomography, or general relativity. Differential geometry is a vast subject. This course covers many of the basic concepts of differential geometry in the simpler context of curves & surfaces in ordinary 3-dimensional Euclidean space. The aim is to build both a solid mathematical understanding of the fundamental notions of differential geometry & enough visual & geometric intuition of the subject. This course is of interest to students from a variety of math, science & engineering backgrounds, & that after completing this course, the students will ready to study more advanced topics such as global properties of curves & surfaces, geometry of abstract manifolds, tensor analysis, & general relativity.

Contents

1 Space Curves
2 Arc length, tangent
3 Normal & binormal
4 Curvature & torsion of a curve
5 Tangent planes
6 The Frenet-Serret apparatus
7 Fundamental existence theorem of plane curves
8 Four vertex theorem, Isoperimetric inequality
9 Surfaces
10 First fundamental form
11 Isometry & conformal mappings
12 Curves on Surfaces, surface Area
13 Second fundamental form
14 Normal & Principle curvatures
15 Gaussian & Mean curvatures
16 Geodesics

Recommended Texts

1. Somasundaran, D. (2005). *Differential geometry* (1st ed.). New Delhi: Narosa Publishing House.
2. Pressley, A. (2001). *Elementary differential geometry* (1st ed.). New York: Springer-Verlag.

Suggested Readings

1. Wilmore, T. J. (1959). *An introduction to differential geometry* (1st ed.). Oxford Calarendon Press.
2. Weatherburn, C. E. (2016). *Differential geometry of three dimensions*. Cambridge University Press.
3. Millman, R. S., & Parker, G. D. (1977). *Elements of differential geometry*. Englewood Cliffs: Prentice Hall.

MATH-6114 **Integral Equations** **3(3-0)**

Many physical problems that are usually solved by differential equation methods can be solved more effectively by integral equation methods. This course will help students gain insight into the application of advanced mathematics & guide them through derivation of appropriate integral equations governing the behavior of several standard physical problems. In addition, a large class of initial & boundary value problems, associated with the differential equations, can be reduced to the integral equations, whence enjoy the advantage of the above integral presentations. This course has many applications in many sciences. This course emphasizes concepts and techniques for solving integral equations from an applied mathematics perspective. Material is selected from the following topics: Volterra and Fredholm equations, Fredholm theory, the Hilbert-Schmidt theorem; Wiener-Hopf Method; Wiener-Hopf Method and partial differential equations; the Hilbert Problem and singular integral equations of Cauchy type; inverse scattering transform; and group theory. Examples are taken from fluid and solid mechanics, acoustics, quantum mechanics, and other applications.

Contents

1 Linear integral equations of the first kind
2 Linear integral equations of the second kind
3 Relationship between differential equation & Volterra integral equation
4 Neumann series
5 Fredholm Integral equation of the second kind with separable Kernels
6 Eigen values, Eigenvectors
7 Iterated functions
8 Quadrature methods
9 Least square methods
10 Homogeneous integral equations of the second kind
11 Fredholm integral equations of the first kind
12 Fredholm integral equations of the second kind
13 Abel's integral equations
14 Hilbert Schmidt theory of integral equations with symmetric Kernels
15 Regularization & filtering techniques

Recommended Texts

1 Jerri, J. (2007). *Introduction to integral equations with applications* (2nd ed.). New York: Sampling Publishing,
2 Wazwaz, A.M. (2011). *Linear & nonlinear integral equations: methods & applications*. New York: Springer.

Suggested Readings

1 Lovitt, W.V. (2005). *Linear integral equations*. New York: Dover Publications.
2 Christian, C., Dale, D., & Hamill, W. (2014). *Boundary integral equation methods & numerical solutions* (1st ed.). New York: Springer.
3 Kanwal, R. P. (1996). *Linear integral equations: theory & technique*. Boston: Birkhauser
4 Tricomi, F. G. (1985). *Integral Equations*. New York: Dover Pub.

MATH-6115 **Functional Analysis** **3(3-0)**

This course extends methods of linear algebra & analysis to spaces of functions, in which the interaction between algebra & analysis allows powerful methods to be developed. The course will be mathematically sophisticated & will use ideas both from linear algebra & analysis. This is a basic graduate level course that introduces the student to Functional Analysis & its applications. It starts with a review of the theory of metric spaces, the theory of Banach spaces & proceeds to develop some key theorems of functional analysis. Then continuous to linear operators in Banach & Hilbert spaces & to spectral theory of self-adjoint operators with applications to the theory of boundary value problems, & the theory of linear elliptic partial differential equations.

Contents

1 Metric Spaces
2 Completeness of metric space
3 Completeness proofs
4 Normed linear Spaces, Banach Spaces
5 Equivalent norms
6 Finite dimensional normed spaces, Linear operator
7 Continuous & bounded linear operators
8 Linear functional, Dual spaces
9 Functional on finite dimensional Spaces
10 Inner product Spaces
11 Hilbert Spaces
12 Conjugate spaces
13 Representation of linear functional on Hilbert space
14 Orthogonal sets
15 Orthonormal sets & sequences
16 Orthogonal complements & direct sum
17 Reflexive spaces

Recommended Texts

1 Kreyszig, E. (1989). *Introduction to functional analysis with applications* (1st ed.). New York: John Wiley & Sons.

Suggested Readings

1 Dunford, N., & Schwartz, J. T. (1958). *Linear operators, part-1 general theory*. New York: Interscience publishers.
2 Balakrishnan, A. V. (1981). *Applied functional analysis* (2nd ed.). New York: Springer-Verlag.
3 Conway, J. B. (1995). *A Course in functional analysis* (2nd ed.). New York: Springer-Verlag.

MATH-6116 **Special Functions** **3(3-0)**

Special functions are particular mathematical functions that have more or less established names & notations due to their importance in mathematical analysis, functional analysis, geometry, physics, or other applications. The term is defined by consensus, & thus lacks a general formal definition, but the List of mathematical functions contains functions that are commonly accepted as special. The main aim of this course is the study of basic special functions & proves the properties & relations related to these functions. Furthermore, the simple sets of polynomials are discussed.

Contents

1 The Weierstrass gamma function
2 Euler integral representation of gamma function
3 Relations satisfied by gamma function
4 Euler's constant
5 Properties of gamma function
6 Beta function, integral representation of beta function
7 Relation between gamma & beta functions
8 Properties of beta function, Legendre's duplication formula
9 Gauss' multiplication theorem
10 Hypergeometric series, the functions F(a,b;c;z) & F(a,b;c;I), integral representation of hypergeometric function,
11 The hypergeometric differential equation, The contiguous relations, Simple transformations,
12 A theorem due to Kummer,
13 Differential equation, Kummer's first formula
14 Simple sets of polynomials, Orthogonality,
15 The three term recurrence relation, The Christofell-Darboux formula,
16 Bessel Functions
17 Generating functions

Recommended Texts

1. Richard, B. (2016). *Special functions & orthogonal polynomials*. Cambridge: Cambridge University Press.
2. Rainville, E. D. (1971). *Special functions* (3rd ed.). New York: The Macmillan Company

Suggested Readings

1. Whittaker, E. T., & Watson, G. N. (1978). *A course in modern analysis*, (2nd ed.). Cambridge: Cambridge University Press.
2. Lebedev, N. N. (1972). *Special functions & their applications* (2nd ed.). New York: Prentice Hall.

MATH-6117 **Graph Theory** **3(3-0)**

The objective of this course is to understand & apply the fundamental concepts in graph theory, apply graph theory-based tools in solving practical problems & to improve the proof writing skills. Graph theory has been applied to several areas of physics, chemistry, communication science, biology, electrical engineering, operations research, psychology, linguistics, among others fields, to solve problems that can be modeled as discrete objects called graphs. Graph theory is intimately related to different branches of mathematics including the group theory, the matrix theory, the numerical analysis, probability, topology, & the combinatorics. Even though some of the problems in graph theory can be described in an elementary way, many of these problems represent a challenge to many researchers in mathematics. The main focus of this course is to understand & apply the fundamental concepts in graph theory. To apply graph theory-based tools in solving practical problems. To improve the proof writing skills.

Contents

1 Graphs & digraphs
2 Degree sequences
3 Paths
4 Cycles, cut-vertices, & blocks
5 Eulerian graph
6 Digraphs
7 Trees
8 Incidence matrix
9 Cut-matrix
10 Circuit matrix & adjacency matrix
11 Orthogonality relation
12 Decomposition
13 Euler formula
14 Planer graphs
15 Non-planer graphs
16 Mengers theorem
17 Hamiltonian's graphs

Recommended Texts

1. Chartrand. G., Lesniak, L., & Zhang, P. (2010). *Graphs & digraphs* (5th ed.). Florida: Chapman & Hall.
2. Ruohonen, K. (2013). *Graph theory* (translation by Janne Tamminen, Kung-Chung Lee & Robert Piché).http://math.tut.fi/~ruohonen/GT_English.pdf

Suggested Readings

1. Robin, J. W. (1996). *Introduction to graph theory* (4th ed.). Boston: Addison Wesley.
2. Bondy, J. A., & Murty, S. U. R. (1976). *Graph theory with applications*. United States: The Macmillian Press Ltd.

MATH-6118 **Advance Group Theory-I** 3(3-0)

This is the first part of the two advance course series of Group Theory. This course aims to introduce students to some more sophisticated concepts & results of group theory as an essential part of general mathematical culture & as a basis for further study of more advanced mathematics. The ideal aim of Group Theory is the classification of all groups (up to isomorphism). It will be shown that this goal can be achieved for finitely generated abelian groups. In general, however, there is no hope of a similar result as the situation is far too complex, even for finite groups. Still, since groups are of great importance for the whole of mathematics, there is a highly developed theory of outstanding beauty. It takes just three simple axioms to define a group, & it is fascinating how much can be deduced from so little. The course is devoted to some of the basic concepts & results of Group Theory.

Contents

1 Group of automorphisms, inner automorphisms, definition & related results
2 Characteristic & fully invariant subgroups,
3 Symmetric Groups, cyclic permutations
4 Even & odd permutations
5 The alternating groups, conjugacy classes of symmetric & alternating groups
6 Generators of symmetric & alternating groups
7 Simple groups
8 Simplicity of symmetric & alternating groups
9 Group Action on sets or G-sets
10 Orbits & stabilizer subgroups
11 Finite direct products
12 Finitely generated abelian groups
13 P-groups, Sylow's Theorems
14 Application of Sylow's Theorems
15 Linear Groups

Recommended Texts

1. Rotman, J. J. (1999). *An Introduction to the theory of groups* (4th ed). New York: Springer.
2. Shah, S. K., & Shankar A. G. (2013). *Group theory*. London: Dorling Kindersley.
3. Dummit, D.S. Foote, R.M. (2003). *Abstract Algebra* (3rd Ed.), USA: Wiley.

Suggested Readings

1. Rose, H. E. (2009). *A course on finite groups* (1st ed). New York: Springer-Verlag.
2. Fraleigh, J. B. (2003). *A first course in abstract algebra* (7th ed.). Boston: Addison-Wesley Publishing Company.
3. Malik, D. S., Mordeson J. N., & Sen M. K. (1997). *Fundamentals of abstract algebra*. New York: WCB/McGraw-Hill.
4. Rose, J. A. (2012). *Course on group theory* (Revised ed.). New York: Dover Publications.

MATH-6119 **Advance Group theory-II** **3(3-0)**

This course is the continuation of the course "Advanced Group Theory-1". This course aims to introduce students to some more sophisticated concepts & results of group theory as an essential part of general mathematical culture & as a basis for further study of more advanced mathematics. The ideal aim of Group Theory is the classification of all groups (up to isomorphism). It will be shown that this goal can be achieved for finitely generated abelian groups. This course covers the advanced topics in group theory such as solvable groups, Upper & Lower Central series nilpotent groups & free groups.

Contents

1 Series in groups
2 Normal series
3 Normal series & its refinement
4 Composition series
5 Equivalent composition series
6 Jordan Holder Theorem
7 Solvable groups, definition, examples & related results
8 Upper & Lower Central series
9 Nilpotent groups
10 Characterization of finite nilpotent groups
11 The Frattini subgroups, definition, examples & related results
12 Free groups, definition, examples & related results
13 Free Product, definition, examples & related results
14 Group algebras

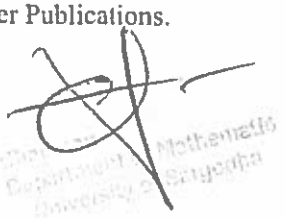
Pre-requisite: Advance Group Theory-I

Recommended Texts

1. Rotman, J. J. (1999). *An Introduction to the theory of groups* (4th ed). New York: Springer.
2. Shah, S.K., & Shankar A. G. (2013). *Group theory*. London: Dorling Kindersley.
3. Dummit, D.S. Foote, R.M. (2003). *Abstract Algebra* (3rd Ed.), USA: Wiley.

Suggested Readings

1. Rose, H. E. (2009). *A course on finite groups* (1st ed). New York: Springer-Verlag.
2. Fraleigh, J. B. (2003). *A first course in abstract algebra* (7th ed.). Boston: Addison-Wesley Publishing Company.
3. Malik, D. S., Mordeson J. N., & Sen M. K. (1997). *Fundamentals of abstract algebra*. New York: WCB/McGraw-Hill.
4. Rose, J. A. (2012). *Course on group theory* (Revised ed.). New York: Dover Publications.



MATH-6120 **Rings & Modules** **3(3-0)**

This course is an introduction to module theory, who knows something about linear algebra and ring theory. Its main aim is the derivation of the structure theory of modules over Euclidean domains. This theory is applied to obtain the structure of abelian groups and the rational canonical and Jordan normal forms of matrices. The basic facts about rings and modules are given in full generality, so that some further topics can be discussed, including projective modules and the connection between modules and representations of groups. It aims to develop the general theory of rings & then study in some detail a new concept, that of a module over a ring. The theory of rings & module is key to many more advanced algebra courses. This subject presents the foundational material for the last of the basic algebraic structure pervading contemporary pure mathematics, namely fields & modules. The basic definitions & elementary results are given, followed by two important applications of the theory. This course introduces concepts of modules. The main objective of this course is to prepare students for courses which require a good back ground in Modules Theory, Primary component & Invariance Theorem etc.

Contents

1 Polynomial rings
2 Division algorithm for polynomials
3 Prime elements, Irreducible elements
4 Euclidean domain
5 Principal ideal domain
6 Greatest common divisor
7 Unique factorization domain
8 Factorization of polynomials over a UFD
9 Irreducibility of polynomials
10 Eisenstein's irreducibility criterion
11 Maximal ideals, Prime ideals, Primary ideals
12 Noetherian rings, Artinian rings
13 Modules, sub modules, Quotient modules
14 Finitely generated & cyclic modules, Exact sequences
15 Elementary notions of homological algebra, Noetherian modules
16 Artinian modules, Radicals, Semisimple modules
17 Tensor product of modules, Bimodules
18 Algebra & coalgebra, Torsion module
19 Primary components, Invariance theorem

Recommended Texts

1. Wang, F., & Kim, H. (2016). *Foundations of commutative rings &their modules* (1st ed.). New York: Springer.
2. Berrick, A. J., & Keating, M. E. (2000). *An introduction to rings &modules: With K-Theory in View* (1st ed.). Cambridge: Cambridge University Press.

Suggested Readings

1. Hartley, B., & Hawkes, T. O. (1980). *Rings, modules &linear algebra (*1st ed.). London: Chapman & Hall.
2. Herstein I. N. (1995). *Topics in algebra with application* (3rd ed.). New York: Books/Cole.

Blyth, T. S. (1977). *Module theory* (1st ed.). Oxford: Oxford University Press.

MATH-6121 **Field Theory** **3(3-0)**

This course will cover basics of abstract rings and fields, which are an important part of any abstract algebra course sequence. We will begin with definitions and important examples. We discuss extension of fields, adjoining roots, and prove the primitive element theorem. Finally, we will classify finite fields. Rings are one of the fundamental languages of mathematics & they play a key role in many areas, including algebraic geometry, number theory, Galios theory & representation theory.

Contents

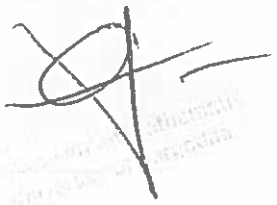
1 Extension fields
2 Finite fields, fields extension,
3 Algebraic elements
4 Transcendental elements
5 Simple extension
6 Galois theory,
7 Galois theory of equations,
8 Construction with straight-edge and compass,
9 Splitting field of polynomials,
10 The Galois groups,
11 Some results on finite groups,
12 Symmetric group as Galois group,
13 Constructable regular n-gones,
14 The Galois group as permutation group.

Recommended Texts

1. Cohn, P. M. (2006). *Free ideal rings & localization in general.* Cambridge: Cambridge University Press.
2. Lang, S. (2005). *Algebra*. Boston: Addison Wesley.

Suggested Readings

1. Herstein, I. N. (1975). *Topics in algebra*. New York: John Wiley & Sons Inc.
2. Hartley, B., & Hawkes, T. O. (1970). *Ring, modules & linear algebra*. Florida: Chapman & Hall
3. Fraleigh, J. A. (1982). *A first course in abstract algebra.* Boston: Addison Wesley.
4. Roman, S. (2005). *Field theory: Graduate texts in mathematics* (2nd ed). Berlin: Springer.



MATH-6122 **Fluid Mechanics-I** **3(3-0)**

This course is the first part of the core level course on fluid mechanics. Fluid mechanics is the branch of physics concerned with the mechanics of fluids (liquids, gases, & plasmas) & the forces on them. It has applications in a wide range of disciplines, including mechanical, civil, chemical & biomedical engineering, geophysics, oceanography, meteorology, astrophysics, & biology. The course of fluid mechanics is introducing fundamental aspects of fluid flow behavior. Students will learn properties of Newtonian fluids; apply concepts of mass, momentum & energy conservation to flows.

Contents

1 Introduction: Definition of Fluid, basics equations
2 Methods of analysis, dimensions & units. Fundamental concepts
3 Fluid as a continuum, velocity field, stress field, viscosity, surface tension, description & classification of fluid motions
4 Fluid Statics: The basic equation of fluid static
5 The standard atmosphere
6 Pressure variation in a static fluid
7 Fluid in rigid body motion. Basic equation in integral form for a control volume
8 Basic laws for a system
9 Relation of derivatives to the control volume formulation
10 Conservation of mass
11 Momentum equation for inertial control volume
12 Momentum equation for control volume with rectilinear acceleration
13 Momentum equation for control volume with arbitrary acceleration
14 The angular momentum principle
15 The first law of thermodynamics
16 The second law of thermodynamics
17 Introduction to differential analysis of fluid motion
18 Conservation of mass
19 Stream function for two-dimensional incompressible flow
20 Motion of a fluid element (kinematics), momentum equation

Recommended Texts

1. Fox, R. W.,& McDonald, A. T. (2004). *Introduction to fluid mechanics* (6th ed.). New York: John Wiley & Sons.
2. White, F. M. (2006). *Fluid mechanics* (5th ed.). New York: Mc. Graw Hill.

Suggested Readings

1. Granger, R. A. (1985). *Fluid mechanics* (1st ed.). Montana: Winston Publisher.
2. Bruce, R., Rothmayer, A. P., Theodore, H. O.,& Wade, W. H. (2013). *Fundamental of fluid mechanics* (7th ed.). New York: Willey Son Publisher.
3. Nakayama, Y. (2018). *Introduction to fluid mechanics* (2nd ed.). Oxford: Butterworh Heinemann Publisher.

MATH-6123 **Fluid Mechanics-II** **3(3+0)**

This course is the second part of the core level course on fluid mechanics. Fluid mechanics is concerned with the mechanics of fluids (liquids, gases, & plasmas) & the forces on them. This course covers properties of fluids, laws of fluid mechanics & energy relationships for incompressible fluids Studies flow in closed conduits, including pressure loss, flow measurement, pipe sizing & pump Selection, momentum equation for frictionless flow, Euler's equations, Bernoulli equation- Integration of Euler's equation, laminar flow & Boundary layers.

Contents

1 Incompressible inviscid flow
2 Momentum equation for frictionless flow
3 Euler's equations
4 Euler's equations in streamline coordinates
5 Bernoulli equation- Integration of Euler's equation along a streamline for steady flow
6 Relation between first law of thermodynamics & the Bernoulli equation
7 Unsteady Bernoulli equation-Integration of Euler's equation along a streamline
8 Irrotational flow, internal incompressible viscous flow
9 Fully developed laminar flow
10 Fully developed laminar flow between infinite parallel plates
11 Fully developed laminar flow in a pipe
12 Part-B Flow in pipes & ducts
13 Shear stress distribution in fully developed pipe flow
14 Turbulent velocity profiles in fully developed pipe flow
15 Energy consideration in pipe flow
16 External incompressible viscous flow
17 Boundary layers, the boundary concept, boundary thickness, laminar flat plate
18 Boundary layer: exact solution, momentum, integral equation,
19 Use of momentum integral equation for flow with zero pressure gradient
20 Pressure gradient in boundary-layer flow

Pre-requisite: Fluid Mechanics-I

Recommended Texts

1. Fox, R. W., & McDonald, A. T. (2004). *Introduction to fluid mechanics* (6th ed.). New York: John Wiley & Sons.
2. White, F. M. (2006). *Fluid mechanics* (5th ed.). New York: Mc. Graw Hill.

Suggested Readings

1. Bruce, R., Rothmayer, A. P., Theodore, H. O., & Wade, W. H. (2013). *Fundamental of fluid mechanics* (7th ed.). New York: Willey Son Publisher.
2. Nakayama, Y. (2018). *Introduction to fluid mechanics* (2nd ed.). Oxford: Butterworh Heinemann Publisher.
3. Granger, R. A. (1985). *Fluid mechanics* (1st ed.). Montana: Winston Publisher.

MATH-6124 **Operations Research-I** 3(3-0)

This course is the 1st part of the course series on operation research. Operations research (OR) is an analytical method of problem-solving & decision-making that is useful in the management of organizations. Operations Research studies analysis and planning of complex systems. In operations research, problems are broken down into basic components & then solved in defined steps by mathematical analysis. The objective of Operations Research, as a mathematical discipline, is to establish theories & algorithms to model & solve mathematical optimization problems that translate to real-life decision-making problems. The purpose of the course is to provide students with the concepts and tools to help them understand the operations research and mathematical modeling methods and to understand different application areas of operations research like transportation problem, assignment model, sequencing models, dynamic programming, game theory, replacement models & inventory models.

Contents

1 Linear Programming
2 Formulation & graphical solution
3 Simplex method, M-technique
4 Two-phase technique
5 Special cases
6 Sensitivity analysis
7 The dual problem
8 Primal dual relationship
9 The dual simplex method
10 Sensitivity
11 Post optimal analysis
12 Transportation model
13 Northwest corner
14 Least cost
15 Vogel's approximation methods
16 The method of multipliers
17 The assignment models
18 The transshipment model
19 Network minimization
20 Shortest route algorithms for variables

Recommended Texts

1. Hamdy, A. T. (2006). *Operations research an introduction* (6th ed.). New York: Macmillan.
2. Gillet, B. E. (1979). *Introduction to operations research* (1st ed.). New York: McGraw Hill.

Suggested Readings

1. Harvy, C. M. (1979). *Operations research: A practical introduction* (1st ed.). North Holland: CRC Press
2. Ravindran, A. R. (2008). *Operations research applications* (1st ed.). North Holland: CRC Press.

MATH-6125 **Operations Research-II** **3(3-0)**

Operations Research (OR) is an analytical method of problem-solving & decision-making that is useful in the management of organizations. In operations research, problems are broken down into basic components & then solved in defined steps by mathematical analysis. Disciplines that are similar to, or overlap with, operations research include statistical analysis, management science, game theory, optimization theory, artificial intelligence & network analysis. All of these techniques have the goal of solving complex problems & improving quantitative decisions. The objective of Operations Research, as a mathematical discipline, is to establish theories & algorithms to model & solve mathematical optimization problems that translate to real life decision making problems. Students would be able to identify & develop complecated operational research modals from the verbal description of the real system. The understanding of the mathematical tools that are needed to solve optimization problems would be increased. They would be analyze the results & propose the theoretical language understandable to decision making processes in Management Engineering.

Contents

1 Algorithm for cyclic network
2 Maximal flow problems
3 Matrix definition of LP- problems
4 Revised simplex methods
5 Bounded variables decompositions algorithm
6 Parametric linear programming
7 Application of integer programming
8 Cutting plane algorithm
9 Mixed fractional cut algorithm
10 Branch methods
11 Bound methods
12 Zero-one implicit enumeration
13 Element of dynamics programming
14 Problems of dimensionality
15 Solutions of linear program by dynamics programming

Pre-requisite: Operation Research-I

Recommended Texts

1. Hamdy, A. T. (2006). *Operations research an introduction* (6th ed.). New York: Macmillan.
2. Gillet, B. E. (1979). *Introduction to operations research* (1st ed.). New York: McGraw Hill.

Suggested Readings

1. Harvy, C. M. (1979). *Operations research*: *A practical introduction* (1st ed.). North Holland: CRC Press

MATH- 6126 **Analytical Dynamics** 3(3-0)

In classical mechanics, analytical dynamics, or more briefly dynamics, is concerned with the relationship between motion of bodies & its causes, namely the forces acting on the bodies & the properties of the bodies, particularly mass & moment of inertia. Analytical dynamics develops Newtonian mechanics to the stage where powerful mathematical techniques can be used to determine the behavior of many physical systems. The mathematical framework also plays a role in the formulation of modern quantum & relativity theories.

Contents

1 Generalized coordinates
2 Constraints
3 Degree of freedom
4 D'Alembert principle
5 Holonomic & non-Holonomic systems, Hamilton's principle
6 Derivation of Lagrange equation from Hamilton's principle
7 Derivation of Hamilton's equation from a variational principle
8 Equations & Examples of Gauge transformations
9 Equations & examples of canonical transformations
10 Orthogonal Point transformations
11 The Principle of Least Action
12 Applications of Hamilton's equation to central force problems
13 Applications to Harmonic oscillator
14 Hamiltonian formulism
15 Lagrange bracket & Poisson brackets with application
16 The Hamilton Jacobi theory, Hamilton Jacobi Theorem
17 The Hamilton Jacobi equation for Hamilton characteristic functions
18 Bilinear co-variant

Recommended Texts

1. Greenwood, D. T. (1965). *Classical dynamics*. New Jersey: Prentice-Hall, Inc.
2. Aruldhas, G. (2016). *Classical mechanics*. New Dehli: PHI Private Limited.
3. Chorlton, F. (1983). *Textbook of dynamics*. Cambridge: E. Horwood.

Suggested Readings

1. Woodhouse, N. M. J. (2009). *Introduction to analytical dynamics* (2nd ed.). New York: Springer-Verlag.
2. Chester, W. (1979). *Mechanics*. London: New South Wales: George Allen & Unwin Ltd.

MATH-6127 **Special Relativity** **3(3-0)**

This course introduces the basic ideas and equations of Einstein's Special Theory of Relativity to understand the physics of Lorentz contraction, time dilation, the "twin paradox", and $E=mc^2$. Calculus Vector transformations Tensors for GTR to understand why we need these two theories. For that see the problems with Galilean transformation & equivalence of inertial & gravitational mass. The most important thing to study SR is to accept geometry as the concept behind it. The math is not difficult; it's the way of thinking you have to adopt. Draw space time diagrams, something to transform to another frame of reference (Lorentz transforms are available). Keep in mind that the view in the other reference frame is just a different view of the same situation that nothing really has changed, even if it looks different on Euclidean paper.

Contents

1 Historical background
2 Fundamental concepts of special theory of relativity
3 Galilean transformations,
4 Lorentz transformations (for motion along one axis)
5 Length contraction
6 Time dilation
7 Simultaneity
8 Velocity addition formulae.3-dimensional
9 Lorentz transformations
10 Introduction to 4-vector formalism
11 Lorentz transformations in the 4-vector formalism
12 Minkowski space-time & null cone
13 4-velocity & 4-momentum & 4-force
14 Application of special relativity to Doppler shift & Compton effect
15 Aberration of light
16 Particle scattering, Binding energy
17 Particle production & decay

Recommended Texts

1. Qadir, A. (1989).*An introduction to the special relativity theory* (1st ed.). Singapore: World Scientific.
2. Sardesai, P.L. (2008). *A primer of special relativity* (2nded.). Delhi: Offset.

Suggested Readings

1. Resnick, R. (1968). *Introduction to special relativity*. New York: Wiley.
2. D'Inverno, R. (1992). *Introducing Einstein's relativity* (1st ed.). Oxford: Oxford University Press.

MATH-6128 **Heat Transfer** **3(3+0)**

Heat transfer is a discipline of thermal engineering that concerns the generation, use, conversion, & exchange of thermal energy (heat) between physical systems. Heat transfer is classified into various mechanisms, such as thermal conduction, thermal convection, thermal radiation, & transfer of energy by phase changes. The objectives of heat transfer include the following: Insulation, wherein across a finite temperature difference between the system & its surrounding, the engineer seeks to reduce the heat transfer as much as possible. The learning outcomes of this course are: to explain the basics of heat transfer, to explain the importance of heat transfer, to define the concept of boiling & condensation, to define the concept of heat exchangers, to explain heat transfer by conduction, to explain the Fourier heat conduction law, to define thermal conductivity coefficient & diffusion coefficient, to explain heat transfer with convection, to explain Newton's law, to explain free transport phenomenon, to explain the forced convection, to explain heat transfer by radiation.

Contents

1 Steady-State Conduction-One Dimension
2 Steady-State Conduction-Multiples Dimensions
3 Unsteady-State Conduction,
4 Principles of Convection
5 Empirical & practical Relations
6 Forced –Convection Heat Transfer
7 Natural Convection Systems
8 Radiation Heat Transfer

Recommended Texts

1. Holman, J. P. (1996). *Heat transfer* (8th ed.). New York: McGraw Hill.
2. Kays, W. M., & Crawford, M. E. (1993). *Convective heat & mass transfer* (3rd ed.). New York: McGraw Hill.

Suggested Readings

1. Incropera, F. P., & Dewitt, D. P. (1985). *Fundamentals of heat & mass transfer* (2nded). New York: Wiley.
2. Cenegel, Y., & Ghajar, A. J. (2015). *Heat & mass transfer: Fundamentals & applications* (5th ed.). New York: Mc-Graw Hill.
3. Lienhar IV, J. H., & Lienhar V, J. H. (2019). *A heat transfer textbook* (5th ed.). New York: Dover Publications.
4. Incropera, F. P. (2006). *Fundamentals of heat & mass transfer* (6th ed.). New York: John Wiley & Sons.

MATH-6129 **Measure Theory** **3(3-0)**

The objectives of the course are to introduce the concepts of measure & integral with respect to a measure, to show their basic properties, to provide a basis for further studies in analysis, probability, & dynamical Systems, to construct Lebesgue's measure & learn the theory of Lebesgue integrals on real line & in n-dimensional Euclidean space. The goal of the course is to develop the understanding of basic concepts of measure and integration theory.As measure theory is a part of the basic curriculum since it is crucial for understanding the theoretical basis of probability and statistics, so it is intended to develop understanding of the theory based on examples of application. After the course the students will know & understand the basic concepts of measure theory & the theory of Lebsgue integration. The students will understand the main proof techniques in the field & will also be able to apply the theory abstractly & concretely. The students will be able to write the elementary proofs himself, as well as more advanced proofs under guidance. The students will be able to use measure theory & integration in Riemann integration & calculus.

Contents

1 Introduction to Lebesgue measure
2 Outer measure
3 Properties of outer measure
4 Further properties of outer measure
5 Measurable sets
6 Properties of measurable sets
7 Non measurable sets
8 Measurable functions
9 Properties of measurable functions
10 Convergence of sequences of measurable functions
11 Lebesuge integration, introduction
12 Lebesgue integrals of simple
13 Bounded functions
14 Lebesgue integrals of non-negative functions
15 Lebesgue integration of general functions
16 General convergence theorems
17 convergence in measure

Recommended Texts

1. Roydon, H. L., & Fitzpatrick, P. M. (2017). *Real analysis* (4th ed.). New York: Collier Macmillan Co.
2. Barra, G. D. (1981). *Measure theory & integration* (1st ed.). Ellis: Harwood Ltd.

Suggested Readings

1. Rudin, W. (1987). *Real &complex analysis*, (3rd ed.). New York: McGraw Hill Book Company.
2. Bartle, R.G. (1995). *The elements of integration & Lebesgue measure*(1st ed.). Wiley-Interscience.
3. Halmos, P. R. (1975). *Measure theory* (1st ed.). New York: Springer.

MATH-6130 **Theory of Splines-I** **3(3-0)**

This is the first part of the two-course series of Theory of Splines. This course is designed to teach students about basics of scientific computing for solving problems which are generated by data using interpolation & approximation techniques & learn how to match numerical method to mathematical properties. This course gives the students the knowledge of problem classes, basic mathematical & numerical concepts & software for solution of engineering & scientific problems formulated as using data sets. After successful completion, students should be able to design, implement & use interpolations for computer solution of scientific problems involving problems generated by set of data. The material covered provides the students with the necessary tools for understanding the many applications of splines in such diverse areas as approximation theory, computer-aided geometric design, curve and surface design and fitting, image processing, numerical solution of differential equations, and increasingly in business and the biosciences.

Contents

1 Basic concepts of Euclidean geometry
2 Scalar & vector functions
3 Barycentric coordinates
4 Convex hull, Matrices of affine maps, Translation, rotation, scaling
5 Reflection & shear, Curve fitting, least squares line fitting
6 Least squares power fit
7 Data linearization method for exponential functions
8 Nonlinear least-squares method for exponential functions
9 Transformations for data linearization
10 linear least squares, Polynomial fitting,
11 Basic concepts of interpolation, Lagrange's method,
12 Rrror terms & error bounds of Lagrange's method
13 Divided differences method,
14 Newton polynomials, error terms & error bounds of Newton polynomials
15 Central difference interpolation formulae
16 Gauss's forward interpolation formula
17 Gauss's backward interpolation formula, Hermite's methods

Recommended Texts

1. David, S. (2006). *Curves & surfaces for computer graphics*. New York: Springer Science + Business Media Inc.
2. John, H. M., & Kurtis, D. F. (1999). *Numerical methods using MATLAB*. New Jersey: Prentice Hall.

Suggested Readings

1. Rao, S. S. (1992). *Optimization theory & applications* (2nd ed.). New York: Wiley Eastern Ltd.
2. Sudaran R. K. (1996). *A first course in optimization theory* (3rd ed.). Cambridge: Cambridge University Press.
3. Chang E. K. P., & Zak, S. I. I. (2004). *An introduction to optimization* (3rd ed.). New York: Wiley.

MATH-6131 **Theory of Splines-II** **3(3-0)**

This is the second part of the two-course series of Theory of Splines. The goal of the course is to provide the students with a strong background on numerical approximation strategies & a basic knowledge on the theory of splines that supports numerical algorithms. Interactive graphics techniques for defining & manipulating geometrical shapes used in computer animation, car body design, aircraft design, & architectural design. In this course follow a modular approach & contribute different components to the development of an interactive curve & surface modeling system. Curve Modeling Techniques: Students will implement various curve interpolation & approximation techniques that allow the interactive specification of three-dimensional curves (e.g. Bezier, B-spline, rational curves). Surface modeling techniques: Students will implement various surface interpolation & approximation techniques that allow the interactive specification of three-dimensional surfaces (e.g. Bezier, B-spline, rational surfaces). Simple, 3D Modeling System: Students will integrate the curve & surface modules into a system that allows the user to interactively design & store simple, 3D geometries.

Contents

1 Parametric curves (scalar & vector case), Algebraic form
2 Hermite form, control point form, Bernstein Bezier form
3 Matrix forms of parametric curves
4 Algorithms to compute B.B. form, Convex hull property
5 Affine invariance property, Variation diminishing property
6 Rational quadratic form, Rational cubic form
7 Tensor product surface, B.B. cubic patch
8 Quadratic by cubic B.B. patch, B.B. quartic patch, Splines, Cubic splines
9 End conditions of cubic splines, Clamped conditions
10 Natural conditions, second derivative conditions
11 Periodic conditions, Not a knot conditions
12 General splines, Natural splines, Periodic splines
13 Truncated power function, Representation of spline in terms of truncated power functions
14 Odd degree interpolating splines

Pre-requisite: Theory of Splines-I

Recommended Texts

1. Farin, G. (2002). *Curves & surfaces for computer aided geometric design, a practical guide* (5th ed.). New York: Academic Press.
2. Faux, I. D., & Pratt, M. J. (1979). *Computational geometry for design & manufacture* (1st ed.). New York: Halsted Press.

Suggested Readings

1. Bartle, H. R., & Beatly, C. J. (2006). *An Introduction to spline for use in computer graphics & geometric modeling* (4th ed.). Massachusetts: Morgan Kaufmann.
2. Boor, C. D. (2001). *A practical guide to splines* (Revised ed.). New York: Springer Verlag.

MATH-6132 **Methods of Optimization-I** **3(3-0)**

Optimization is a widely used technique in operational research that has been employed in a range of applications. The aim is to maximize or minimize a function (e.g. maximizing profit or minimizing environmental impact) subject to a set of constraints. At the start of the course, the course delivery, the prerequisites of the course will be discussed. The objective of this course is to make students acquire a systematic understanding of optimization techniques. The course will start with linear optimization (being the simplest of all optimization techniques) and will discuss in detail the problem formulation and the solution approaches. Then we will cover a class of nonlinear optimization problems where the optimal solution is also globally optimal, i.e. convex nonlinear optimization and its variants. On successful completion of the course the students will be able to model engineering maxima/minima problems as optimization problems. The students will be able to use computers to implement optimization algorithms. The students will learn efficient computation procedures to solve optimization problems.

Contents

1 Introduction to optimization
2 Review of related mathematical concepts
3 Unconstrained optimization
4 Conditions for local minimizers
5 One dimensional search methods
6 Gradient methods
7 Newton's method (analysis & modifications)
8 Conjugate direction methods
9 Quasi Newton method
10 Application to neural network
11 Single Neuron Training
12 Linear integer programming
13 Genetic algorithms
14 Real number genetic algorithm

Recommended Texts

1. Chong, E. K. P., & Stanislaw, H. Z. (2012). *An introduction to optimization* (4th ed.). New York: Wiley Series in Discrete Mathematics & Optimization.
2. Singiresu, S. R. (1992). *Optimization theory & applications* (2nd ed.). New York: Wiley Eastern Ltd.

Suggested Readings

1. Sundaram, R. K. (1996). *A first course in optimization theory,* (3rd ed.). Cambridge: Cambridge University Press.
2. Bertsimas, D., Tsitsiklis, J. N., & Tsiitsiklis, J. (1997). *Introduction to linear optimization* (2nd ed.). Belmont: Athena Scientific

MATH-6133 **Methods of Optimization-II** **3(3-0)**

This is continuation of Methods of Optimization I. Optimization is a widely used technique in operational research that has been employed in a range of applications. The aim is to maximize or minimize a function (e.g. maximizing profit or minimizing environmental impact) subject to a set of constraints. At the start of the course, the course delivery, the prerequisites of the course will be discussed. Students will learn the foundations of linear programming, properties of optimal solutions and various solution methods for optimizing problems involving a linear objective function and linear constraints. Students will be exposed to geometric, algebraic and computational aspects of linear optimization and its extensions. On successful completion of the course the students will be able to model engineering maxima/minima problems as optimization problems. The students will be able to use computers to implement optimization algorithms. The students will learn efficient computation procedures to solve optimization problems.

Contents

1 Non-linear constrained optimization
2 Problems with equality constraints
3 Problem Formulation
4 Tangent spaces
5 Normal spaces
6 Lagrange condition
7 Second-order conditions
8 Problems with inequality constraints
9 Karush-Kuhn-Tucker Condition
10 Second-order conditions
11 Convex optimization problems
12 Convex functions
13 Algorithms for constrained optimization
14 Lagrangian algorithms

Pre-requisite: Methods of Optimization-I

Recommended Texts

1. Chong, E. K. P.,& Stanislaw, H. Z. (2012).*An introduction to optimization* (4th ed.). New York: Wiley Series in Discrete Mathematics & Optimization.
2. Singiresu, S. R. (1992). *Optimization theory & applications* (2nd ed.). New York: Wiley Eastern Ltd.

Suggested Readings

1. Sundaram, R. K. (1996). *A first course in optimization theory,* (3rd ed.). Cambridge: Cambridge University Press.
2. Bertsimas, D., Tsitsiklis, J. N., & Tsiitsiklis, J. (1997). *Introduction to linear optimization* (2nd ed.). Belmont: Athena Scientific.

MATH-6134 **Bio-Mathematics** **3(3-0)**

The objective of this course is to meet the current and future needs for the interaction between mathematics and biological sciences. Mathematical modeling is being applied in every major discipline in the biomedical sciences. A very different applications, and surprisingly successful, is in psychology, modeling of various human interactions, blood flow and functioning of different organs in human body.

Contents

1 An introduction to the use of continuous and discrete differential equations in the biological sciences,
2 Biological topics will include single species and interacting population dynamics,
3 modeling infectious and dynamic diseases,
4 Regulation of cell function,
5 Molecular interactions, neural and biological oscillators, and an introduction to biological pattern formation,
6 Mathematical tools such as phase portraits, bifurcation diagrams, perturbation theory,
7 Parameter estimation techniques that analyze and interpret biological models.

Recommended Books

1 Murray, J.D., *Mathematical Biology*, (Springer-Verlag, 2001).
2 Keener, J. and Sneyd, J., *Mathematical Physiology*, (Springer, New York, 1998).

Suggested Books

1 Murray, J.D., *Nonlinear Differential Equation Models in Biology*, (Clarendon Press, Oxford, 1977).

List of Interdisciplinary/Allied Courses

CMPC-5201 **Programming Fundamentals** **3(2-1)**

This course provides fundamental concepts of programming to freshmen. The courses is prerequisite to many other courses, therefore, students are strongly advised to cover all contents and try to achieve CLOs to the maximum possible level. The course may be taught as language independent. Further, it is up to the university to choose any language for the practical/Lab purpose but that must be latest and market oriented.

Contents

1. Introduction to problem solving, a brief review of Von-Neumann architecture
2. Introduction to programming, role of compiler and linker
3. Introduction to algorithms, basic data types and variables
4. Input/output constructs, arithmetic
5. Comparison and logical operators
6. Conditional statements and execution flow for conditional statements
7. Repetitive statements and execution flow for repetitive statements
8. Lists and their memory organization, multidimensional lists
9. Introduction to modular programming
10. Function definition and calling
11. Stack rolling and unrolling
12. String and string operations
13. Pointers/references
14. Static and dynamic memory allocation
15. File I/O operations.

Recommended Texts:

1. Object Oriented Programming in C++ latest edition by Robert Lafore
2. Starting Out with Programming Logic and Design: latest edition by Tony Gaddis.
3. The C Programming Language, 2nd Edition by Brian W. Kernighan, Dennis M. Ritchie.

Suggested Readings:

1. C++ How to Program latest Edition by Paul Deitel and Harvey Deitel
2. Problem Solving and Program Design in C++, latest Edition by Jeri R. Hanly& Elliot B. Koffman.

STAT-5111 **Statistics and Probability Theory** **3(3-0)**

This course introduces fundamental concepts of statistics and probability theory, providing students with the analytical tools to collect, summarize, interpret, and draw conclusions from data. Emphasis is placed on understanding descriptive statistics, probability rules, random variables, probability distributions, and basic inferential techniques. The course also highlights practical applications in research and decision-making across disciplines.

Contents

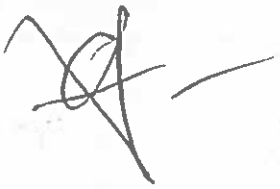
1. Introduction to Statistics: Definition and importance of statistics, Types of statistics, Types of data, Scales of measurement.
2. Data Collection and Presentation: Population and sample, Data collection methods, Frequency distributions and tables, Graphical presentations
3. Descriptive Statistics: Measures of central tendency, Measures of dispersion, Measures of Position/Location, Measures of Skewness and Kurtosis.
4. Introduction to Probability: Basic probability concepts, Counting techniques, Conditional probability, Independence and product rule, Bayes theorem.
5. Random Variables and Probability Distributions: Concept of random variable, Discrete and continuous random variables, Joint probability distributions, Marginal probability distributions, Independence of random variables, Conditional probability distribution.
6. Mathematical Expectation: Concept of expectation, mean of random variable, Variance and covariance of random variable, Mean and variance of linear combination of random variable, Chebyshev's inequality.
7. Some Discrete Probability Distributions: Bernoulli, Binomial.
8. Some Continuous Probability Distributions: Uniform, Normal distribution.
9. Sampling and Sampling Distributions: Central Limit Theorem, Sampling distribution of the mean.
10. Estimation: Point and interval estimation, Confidence intervals for means (known and unknown variance).
11. Hypothesis Testing: Null and alternative hypotheses, Type I and Type II errors, Test statistics and p-values, One-sample and two-sample tests (Z-test, t-test).

Recommended Texts

1. Linde, W. (2024). Probability Theory: A First Course in Probability Theory and Statistics. Walter de Gruyter GmbH & Co KG.
2. Mendenhall, W., Beaver, R. J., & Beaver, B. M. (2012). Introduction to probability and statistics. Cengage Learning. New Delhi, 744.
3. Triola, M. F., Goodman, W. M., Law, R., & Labute, G. (2004). Elementary statistics (p. 794). Reading, MA: Pearson/Addison-Wesley.

Suggested Readings

1. Walpole, R. E., Myers, R. H., Myers, S. L., & Ye, K. (2011). Probability and Statistics for Engineers and Scientists, 9th. ed: Pearson, January.
2. Modica, G., & Poggiolini, L. (2012). A first course in probability and Markov Chains. John Wiley & Sons.



CSEC-6101 **Programming Languages for Mathematicians** 3(2-1)

Programming Languages plays an important role in Mathematics. More often, the act of programming involves problem-solving in itself, where you then take your answers and apply them to build a program. However, mathematicians sometimes require some programming languages for assistance, and some of the best programming languages for math work wonders when you're trying to hone your skills and train yourself in a particular mathematical field. A number of computer software available to deal with mathematical computing & simulation. This course provides a practical introduction to most widely used Mathematical computing software's namely, MATHEMATICA or MAPLE. Maple has a fairly strong advantage when it comes to combinatorial math problems. It's also known for its functional programming constructs, making it extremely interesting to play around with. After this course students will be able to develop computer programs in this software according to their requirements in mathematical computing. It includes introduction to data-oriented Python packages, decision trees, support vector machines (SVM), neural networks, and machine learning.

Contents

Mathematica

1 Introduction to the basic environment of MATHMATICA & its syntax
2 Running MATHEMATICA
3 Numerical/Algebraic Calculations, vectors, Matrices, Sets, Lists, Tables, arrays
4 Symbolic Mathematics in MATHEMATICA
5 Functions & functional programming
6 Procedural programming, Do, for & while loops, Flow controls
7 Graphics, Plots of 2D & 3D functions, Packages within MATHEMATICA

Maple

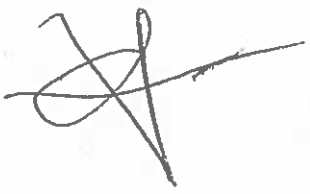
1. Introductory Demonstration of Maple, symbolic computations in MAPLE
2. Vectors, Matrices, Sets, Lists, Tables, arrays & Arrays, Toolbars & Palettes
3. Operators, Constant, Elementary Functions, Procedures
4. If clauses, selection & conditional execution
5. Looping, for & while loop, looping commands, recursion
6. Plots of 2D & 3D functions, Packages within MAPLE

Recommended Texts

1. Wellin, P., Kamin, S., & Gaylord R. (2011). *An introduction to programming with mathematica*, (3rd ed.). Cambridge: Cambridge university press.
2. Monagan, M. B., & Geddes, K. O. (2005). *Maple introductory programming guide*. Waterloo: Maplesoft, a division of Waterloo Maple Inc.

Suggested Readings

1. Aladjev, V. Z., & Bogdivicus, M. A. (2006). *Maple: Programming, physical & engineering Problems*. London: Fultus Publishing.
2. Maeder, R. E. (1997). *Programming in mathematica* (3rd ed.). Boston: Addision-Weseley.
3. Hoste, J. (2009). *Mathematica demystified*. New York: McGraw Hill.



PHYS-6130 **Introduction to Mechanics** **3(2-1)**

Mechanics is all about motion of a body. It deals with forces, motion and further to the laws of motion in inertial frames specifically. This course provides the students a broad understanding of the physical principles of the mechanics, to describe mechanical events that involve forces acting on macroscopic objects. The main objective of this course is to create quantitative skills in the students and to motivate them to think creatively and critically about scientific problems and experiments. Students are encouraged to share their thinking with teacher and the other students to examine different problem-solving strategies.

Contents

1. Motion in Two and Three Dimensions: Projectile Motion, Uniform Circular motion
2. Force and Motion: Newton's Laws, Some Particular Forces, Drag Force, Frictional Force, Terminal Speed
3. Kinetic Energy and work: Work done by Gravitational force, Work done by Spring Force, Work done by General variable force, Power
4. Potential Energy and Conservation of energy: Reading a potential energy curve, Work done on a system by an external force,
5. Center of Mass and Linear Momentum: center of mass, Newton's second law for a system of particles, linear momentum, two particle and many-particle systems, center of mass of solid objects, momentum changes in a system of variable mass. Collisions in the center-of-mass reference frame.

Experiments

1. To determine the value of 'g' by a compound pendulum
2. To determine the surface tension of water by capillary tube method
3. Determination of moment of inertia of a solid/hollow cylinder and a sphere etc.
4. To study the conservation of energy (Hook's Law)
5. To study the laws of vibration of stretched string-using sonometer

Recommended Texts:

1. Halliday, D., Resnick, R. & Walker, J. (2014). *Fundamentals of physics* (10th Ed.). New York: Wiley.
2. Halliday, D., Resnick, R. & Krane, K. S. (2003). *Physics* (5th Ed.). New York: Wiley.

Suggested Readings:

1. Young, H. D., Freedman, R. A. & Ford, A. L. (2019). *University physics* (15th Ed.). New York: Pearson.
2. Serway, R. A. & Jewelt, J. W. (2014). *Physics for scientists and engineers* (9th Ed.). New York: Brooks/Cole.

AIDC-4102 **Machine Learning** **3(2-1)**

Machine learning is one of the fastest growing areas of computer science, with far-reaching applications. The aim of this course is to:

a) Present the basic machine learning concepts.

b) Present a range of machine learning algorithms along with their strengths and weaknesses.

Apply machine learning algorithms to solve problems of moderate complexity.

Contents

1. Introduction to machine learning
2. concept learning: General-to-specific ordering of hypotheses
3. Version spaces Algorithm, Candidate elimination algorithm
4. Supervised Learning: decision trees, Naive Bayes
5. Artificial Neural Networks, Support Vector Machines
6. Overfitting, noisy data, and pruning, Measuring Classifier Accuracy
7. Linear and Logistic regression
8. Unsupervised Learning: Hierarchical Aglomerative Clustering
9. k-means partitional clustering; Self-Organizing Maps (SOM);
10. k-Nearest-neighbor algorithm
11. Semi- supervised learning with EM using labeled and unlabled data
12. Reinforcement Learning: Hidden Markov models
13. Monte Carlo inference Exploration vs. Exploitation Trade-off
14. Markov Decision Processes
15. Ensemble Learning: Using committees of multiple hypotheses
16. Bagging, boosting

Recommended Texts:

1. Kelleher, J. D. (2019). Machine learning: The basics. MIT Press.
2. Alpaydin, E. (2021). Introduction to machine learning (4th ed.). MIT Press.

Suggested Readings:

1. Mitchell, T. M. (1997). Machine learning. McGraw-Hill.
2. Murphy, K. P. (2012). Machine learning: A probabilistic perspective. MIT Press.

EDUC-6129 **Scientific Writing & Research Method** **3(3-0)**

This course use to introduce BS students to the basic concepts, principles and practices of scientific writing and research method in the social sciences. The course is designed to equip students with the skills necessary to communicate scientific information clearly and effectively. It also equips with the knowledge and skills necessary to design, conduct, analyse, and report empirical research. The course covers quantitative methodologies, research design, sampling techniques, data collection methods, and ethical considerations.

Contents

Unit 1: Foundations of Scientific Writing

1. Introduction to Scientific Writing
2. Structure of Scientific Papers (IMRaD Format)
3. Types of Scientific Documents (articles, reviews, theses, etc.)

Unit 2: The Nature of Educational Research

4. Definitions of Research, scope and importance
5. Research problem and topic
6. Characteristics of research problem

Unit 3: Variables and Hypotheses/Research Questions

7. Variable and Types of Variables
8. Hypotheses and Research Questions
9. Types of hypotheses and Testing the Hypothesis

Unit 4: Research Methodology

9. Research Domains: Qualitative, Quantitative, and Mix-method
10. Types of Research Designs: Descriptive, Correlation, Experimental
11. Population and Sampling Techniques
12. Development and Validation of Research Tool
13. Data Analysis: Descriptive and Inferential

Unit 5: Research Proposal and Report Writing

14. Writing formats
15. Proper Referencing and Citation Styles (APA, MLA, Chicago, etc.)
16. Ethics in Scientific Writing (Plagiarism, Authorship, Data Fabrication)

Recommended Text

1. Garg, R. (2024). *Research Methodology and Scientific Writing* (2nd ed.). Springer. https://doi.org/10.1007/978-3-030-64865-7

Suggested Readings

1. John, W. C. (2018). *Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research*, (6th Ed.), New York: Pearson Education. Retrieved from http://www.sxf.uevora.pt/wp-content/uploads/2013/03/Creswell_2012.pdf

PHYS-6131 **Introduction to Classical Mechanics** **3(3-0)**

The fundamental goal of this course is to create understanding in students to classical mechanics and its applications. The focus in this course will be given to develop knowledge of the physical concepts and mathematical methods of classical mechanics to improve skills in formulating and solving physics problems. Students will learn the use of Newton's laws of motion, conservation theorems to solve advanced problems involving the dynamic motion of classical mechanical systems.

Contents

1. Newtonian Mechanics-Single Particle: Newton's Laws
2. Frame of Reference, The Equation of motion for a particle
3. Conservation theorems, Energy
4. Limitations of Newtonian Mechanics
5. Oscillations: Simple Harmonic Oscillator
6. Harmonic Oscillations in Two dimensions
7. Damped Oscillations, Sinusoidal Driving Force
8. Physical Systems.
9. Gravitation: Gravitation Potential, Lines of Force and Equipotential Surfaces
10. Ocean Tides
11. Central Force Motion: Conservation Theorems, Equations of Motion
12. Orbits in a central Field, Centrifugal Energy and Effective Potential
13. Planetary Motion-Kepler's Problem, Orbital Dynamics
14. Dynamics of System of Particles: Center of mass
15. Linear momentum of system
16. Angular momentum of system

Recommended Texts:

1. Thornton, S. T. & Marion, J. B. (2012). *Classical dynamics of particles and systems* (5th ed.). New York: Thomson Brooks/Cole

2. Tai L. Chow. (2010). *Classical mechanics* (2nd ed). Taylor and Francis. California USA

3. Goldstein, H., Charles, P. P. & Safko J. L. (2001). *Classical mechanics* (3rd ed). Massachusetts: Addison Wesley Reading.

Suggested Readings:

1. Taylor, J. R. (2005). *Classical mechanics.* California: University Science Books.