CENTRAL UNIVERSITY OF JAMMU

B.TECH IN ELECTRONICS AND COMMUNICATION ENGINEERING

DEPARTMENT OF COMPUTER SCIENCE AND INFORMATION TECHNOLOGY

SCHOOL OF BASIC AND APPLIED SCIENCES

Central University of Jammu
Samba, Jammu & Kashmir, India

About

A 4-year degree B.Tech programme in Electronics and Communication Engineering, at Central University of Jammu has been started in 2022. It includes microwave technology, electromagnetic engineering, signal processing, analog and digital communications, VLSI, and other fields. Gaining expertise in the field of Electronics and Communication Engineering through the teaching of subject-specific information, hands-on experience, and the instillation of moral principles. The students must be prepared to become the resources needed in the future to support the development of technology in a way that is both sustainable and beneficial to society.

Program Educational Objectives (PEO)	
PEO-1	Analyze, plan and apply the acquired knowledge in basic sciences and mathematics in solving Electronics and Communication Engineering problems with technical, economic, environmental and social contexts.
PEO-2	Design, build and test analog and digital electronic systems for given specifications
PEO-3	Communicate effectively, demonstrate leadership qualities and exhibit professional conduct in their career.
PEO-4	Work in a team using technical knowhow, common tools and environments to achieve project objectives.
PEO-5	Engage in lifelong learning, career enhancement and adapt to changing professional and societal needs

Program Articulation Matrix

PEO / Mission Statements	PEO1	PEO2	PEO3	PEO4	PEO5
Offering high quality education through careful crafted curriculum that are in line with the strict networking requirements of the industries.	3	3	2	3	2

Providing state of the art research facilities in the focus areas of electronics and communication engineering to deliver knowledge and develop latest technologies.	2	3	3	3	2
Creating connections with world-class organizations in order to strengthen industry-academia collaborations for mutual benefit.	2	3	2	3	2

1-Slightly; 2-Moderately; 3-Substantially

Program Outcomes (PO)	
PO-1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and Electronics and Communication Engineering to the solution of complex engineering problems.
PO-2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO-3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO-4	**Conduct investigations of complex problems**: Use research-based knowledge andresearch methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO-5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineeringactivities with an understanding of the limitations.
PO-6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilitiesrelevant to the professional engineering practice.
PO-7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO-8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO-9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
PO-10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO-11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO-12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)	
PSO-1	Analyze and design of electronic circuits and Communication systems to enhance the quality of human life
PSO-2	Develop innovative and environment-conscious technologies to sustain human life

COURSE SCHEME

B.TECH. ELECTRONICS AND COMMUNICATION ENGINEERING

SEMESTER-I

Course Code	Course Title	Credits	L	T	P	CIA	MSE	ESE	Marks
BEECE1C01IN	Induction Program	-	2	-	-	-	-	-	-
BEECE1C001T	Environmental Studies	-	2	-	-	-	-	-	-
BEECE1C002T	Applied Mathematics	3	3	0	0	18.75	18.75	37.5	75
BEECE1C003T	Applied Physics	3	3	0	0	18.75	18.75	37.5	75
BEECE1C001L	Applied Physics Laboratory	2	0	0	2	12.5	12.5	25	50
BEECE 1C004T	English for Technical Communication	3	3	0	0	18.75	18.75	37.5	75
BEECE1C006T	Problem Solving and Computer Programming in C	4	3	1	0	25	25	50	100
BEECE1C005T	Electronic Devices and Circuits	3	3	0	0	18.75	18.75	37.5	75
BEECE1C002L	Electronic Devices and Circuits Laboratory	2	0	0	2	12.5	12.5	25	50
		20	-	-	-	-	-	-	500

Course Syllabus

(Semester-I)

Applied Mathematics

Course Code: BEECE1C002T

Course Title: Applied Mathematics

Semester: I

Credits: 03

Rationale

To familiarize with the important tools and theorems of calculus and differential equations is essential in all the branches of engineering. It will also develop the in-depth knowledge of types and operations on matrices and algebra in a comprehensive manner.

Course Outlines

Contents	**No. of Lectures**
Unit - I Linear dependence and independence of vectors, Rank of a matrix, Consistency of the system of linear equations, Eigen values and eigenvectors of a matrix, Caley-Hamilton theorem and its applications, Reduction to diagonal form.	**10**
Unit - II Reduction of a quadratic form to canonical form - orthogonal transformation and congruent transformation, Properties of complex matrices - Hermitian, skew-Hermitian and Unitary matrices.	**10**
Unit -III Taylor's theorem with remainders, Taylor's and Maclaurin's expansions, Asymptotes, Curvature; Curve tracing, Functions of several variables - partial differentiation, total differentiation, Euler's theorem and generalization, Change of variables – Jacobians, maxima and minima of functions of several variables (2 and 3 variables) - Lagrange's method of multipliers	**10**
Unit - IV Geometric interpretation of solutions of first order ODE $y' = f(x, y)$, Exact differential equations, integrating factors, orthogonal trajectories, Higher order linear differential equations with constant coefficients - homogeneous and non- homogeneous.	**10**
Unit - V Euler and Cauchy's differential equations; Method of variation of parameters; System of linear differential equations; applications in physical problems - forced oscillations, electric circuits, etc	**10**

Course Outcomes

Upon successful completion of this course, candidates will be able to:

- Solve the consistent system of linear equations
- Apply orthogonal and congruent transformations to a quadratic form.
- Find the maxima and minima of multivariable functions
- Solve arbitrary order linear differential equations with constant coefficients
- Apply the concepts in solving physical problems arising in engineering.

Text Books

1. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa Publishing House, 2016, Fifth Edition.
2. Calculus and Analytic Geometry, George B. Thomas and Ross L. Finney, Pearson, 2020, Ninth Edition.

Reference Books

1. Advanced Engineering Mathematics, Erwin Kreyszig, John Wiley and Sons, 2015, Eighth Edition.
2. Advanced Engineering Mathematics, Dennis G. Zill, Jones & Bartlett Learning, 2018, Sixth Edition
3. Higher Engineering Mathematics, B. S. Grewal, Khanna Publishers, 2012, Forty-second Edition.

Applied Physics

Course Code: BEECE1C003T

Course Title: Applied Physics

Semester: I

Credits: 03

Rationale

Understand the significance of Dielectric Materials and Piezoelectric materials basis of Electromagnetic Theory. Differentiate between the various types of referential frames. Gain the knowledge on the basic concepts of Quantum Mechanics and its applications. Understand the working principle of various lasers and their application in various fields.

Course Outlines

Contents	**No of Lectures**
Unit-I Dielectric Materials - Introduction to Dielectrics, Dielectric constant, polarizability, properties and types of insulating materials, polarization mechanisms in dielectrics (Qualitative), frequency and temperature dependence of polarization, dielectric loss, Clausius-Mossotti equation (qualitative), dielectric breakdown, applications in electrical engineering (electrolytic capacitor). Piezoelectric materials - Properties, production and detection of ultrasonic, applications in electrical engineering. Functional Materials - Fiber reinforced plastics, fiber reinforced metals, surface acoustic wave materials, high temperature materials and smart materials, properties and applications	**10**
Unit-II Quantum Mechanics - Introduction to quantum theory, concepts and experiments led to the discovery, wave particle duality, Davisson-Germer experiment, Heisenberg uncertainty principle, Schrodinger time independent wave equation, the free particle problem, particle in an infinite and finite potential well, quantum mechanical tunnelling and applications.	**10**
Unit-III Optical Fibers and Devices - Principle and working of optical Fiber, structure, Classification and advantages of optical fiber, Light guiding mechanism in Optical Fibers, Numerical Aperture, Dielectric Slab wave Guide and Modes, Maxwell's Equations, Waveguide Equations and solutions (qualitative) under	**10**

weekly guiding approximation, Modes in Step-Index fibers, LP Modes and their designation, Signal Degradation in optical fibers, Attenuation - Absorption, Scattering, bending and Core-Cladding losses, Material, Waveguide, Inter and intra modal Dispersions.	
Unit-IV Light Sources - Basics of Semiconductor Physics, PN Junctions, LEDs and LED Structures, Quantum efficiency and LED Power and modulation of LED, Laser Diodes, Laser Diode Rate Equations and Quantum Efficiency (qualitative treatment).	**10**
Unit-V Solar Cells - Solar spectrum, photovoltaic effect, structure and working principle of solar cell, I-V characteristics, power conversion efficiency, materials for PV, emerging PV technologies for alternative energy devices. Thermal Physics - Thermo electric laws, Seebeck effect, Peltier effect, Thompson effect, Thermocouples, types, characteristics and laws, Thermistors, Resistance Temperature Detector.	**10**

Course Outcomes

Upon successful completion of this course, candidates will be able to:

- Apply the concepts of wave and particle nature of matter and energy for solving problems radiant energy.
- Understand the physics of optical fibers, diode lasers and their applications in communication.
- Understand the basics of dielectric and functional materials and their applications in electrical engineering.
- Comprehend the working of solar cells and emerging photovoltaic technologies.
- Understand temperature measurement using thermocouples and thermistors

Text Books

1. Fundamentals of Physics by Halliday, Resnic and Walker, John Wiley, Ninth Edition, 2011.
2. Concepts of Modern Physics by Arthur Beiser, Shobhit Mahajan, S. Rai Choudhury, McGraw Hill Publications, Sixth edition,2009.

Reference Books

1. Optical Fiber Communications, by Gerd Keiser, McGraw Hill Education, 5th Edition, 2017.
2. Optics by Ajoy K. Ghatak,Tata McGraw Hill, Sixth Edition, 2017
3. Understanding Lasers An Entry-Level Guide, by Jeff Hecht, Wiley Publications, Fourth edition, 2018.
4. A Text Book of Engineering Physics by M.N. Avadhanulu, P.G. Khirsagar, 9th edition, 2011.
5. University Physics with modern physics by Hugh D. Young, Roger A. Freedman Pearson Education, 2014.

APPLIED PHYSICS LABORATORY

Course Code: BECCS1C001L

Course Title: Applied Physics Laboratory

Semester: I

Credits: 02

Rationale

Applied physics practical's aims to give an understanding of this world both by observation and prediction of the way in which objects will behave. Concrete uses of physical principles and analysis in various fields of engineering and technology are given prominence.

List of experiments

1. Determination of Wavelength of Sodium light using Newton'sRings.
2. Determination of Wavelength of He-Ne laser – MetalScale.
3. Measurement of Width of a narrow slit using He- NeLaser.
4. Determination of Specific rotation of Cane sugar by Laurent Half-shadePolarimeter.
5. Determination of capacitance by using R-Ccircuit.
6. Determination of resonating frequency and bandwidth by LCRcircuit.
7. Measurement of half-life of radioactive source using GMCounter.
8. Diffraction grating by normal incidence method.
9. Measurement of numerical aperture of opticalfiber.

Course Outcomes

At the end of the course, the student will be able to

- Use CRO, signal generator, spectrometer, polarimeter and GM counter for making measurements
- Test optical components using principles of interference and diffraction of light
- Determine the selectivity parameters in electrical circuits
- Determine the width of narrow slits, spacing between close rulings using lasers and appreciate the accuracy in measurements

Text Books

1. "*Physics Laboratory Manual"* by Physics Department, NITWarangal,2021.
2. P.R. Sasi Kumar, "*Practical Physics*", PHI publications, firstedition,2011

Reference Books/ Online Resources

1. G.L.Squire, "*Practical Physics*", Cambridge University press, fourthedition,2001.
2. Dr.S.K.GuptaKrishna,"*Engineering Physics Practical*", Prakashan Publications,

ninth edition,2010.
3. https://nptel.ac.in/courses/115/105/115105110/

English for Technical Communication

Course Code: BEECE1C004T

Course Title: English for Technical Communication

Semester: I

Credits: 03

Rationale

The goal of this course is to prepare engineering students with the individual and collaborative technical writing, presentation, and research skills necessary to be effective technical communicators in academic and professional environments.

Contents	**No. of Lectures**
Unit-I Grammar Principles (Correction of sentences, Concord) and Vocabulary Building (synonyms and antonyms) - Idioms and Phrasal verbs, patterns of use and suggestions for effective employment in varied contexts. Effective Sentence Construction - Strategies for bringing variety and clarity in sentences, removing ambiguity, editing long sentences for brevity and clarity.	**10**
Unit - II Reported speech - Contexts for use of reported speech, its impact on audiences and readers, active and passive voice, reasons for preference for passive voice in scientific English. Paragraph-writing - Definition of paragraph, types, features of a good paragraph, unity of theme, coherence, linking devices, direction, patterns of development.	**10**
Unit -III Note-making – Definition, the need for note-making, its benefits, various note formats, like tree diagram, block or list notes, tables, etc. Letter-Writing - Its importance in the context of other channels of communication, qualities of effective letters, types- personal & official letters for various purposes, emphasis on letter of application for jobs, cover letter and resume types, examples and exercises.	**10**
Unit - IV Reading techniques - Definition- Skills and sub-skills of reading, Skimming and Scanning, their uses and purposes, examples and exercises. Reading Comprehension - Reading silently and with understanding, process of comprehension, types of comprehension questions (technical paper reading, patents).	**10**
Unit - V Features of Technical English - Description of technical objects and process, Report-Writing - definition, purpose, types, and structure, formal and informal reports, stages in developing report, proposal, progress and final reports examples and exercises. Book Reviews - Oral and written review of a chosen novel/play/movie, focus on	**10**

appropriate vocabulary and structure, language items like special vocabulary and idioms used.	

Course Outcomes

Upon successful completion of this course, candidates will be able to:

- Understand basic grammar principles
- Write clear and coherent passages
- Write effective letters for job application and complaints
- Prepare technical reports and interpret graphs
- Enhance reading comprehension
- Comprehend English speech sound system, stress and intonation

Text books

1. English for Engineers and Technologists (Combined edition, Vol. 1 and 2) Orient Blackswan 2010.
2. Ashraf, M Rizvi. Effective Technical Communication. Tata McGraw-Hill, 2006

Reference books

1. Meenakshi Raman and Sangeetha Sharma. Technical Communication: Principles and Practice 2nd Edition, Oxford University Press, 2011.

Language laboratory

1. English Sound System - vowels, consonants, Diphthongs, phonetic symbols using dictionary to decode phonetic transcription, Received Pronunciation, its value and relevance, transcription of exercises.
2. Stress and Intonation - word and sentence stress, their role and importance in spoken English
3. Intonation in spoken English - definition, patterns of intonation, falling, rising, etc., use of intonation in daily life-exercises
4. Introducing one in formal and social contexts- Role plays, their uses in developing fluency and communication in general.
5. Oral presentation - definition, occasions, structure, qualities of a good presentation with emphasis on body language and use of visual aids.
6. Listening Comprehension - Challenges in listening, good listening traits, somestandard listening tests, practice and exercises.
7. Debate/ Group Discussions - concepts, types, Do’s and don’ts, intensive practice.

Software

1. Clear Pronunciation – Part-1 Learn to Speak English.
2. Clear Pronunciation – Part-2 Speak Clearly with Confidence
3. Study Skills
4. English Pronunciation

Electronic Devices and Circuits

Course Code: BEECE1C005T

Course Title: Electronic Devices and Circuits

Semester: I

Credits: 03

Rationale

The course aims to impart knowledge about the basic concepts of Electronic Devices and Circuits. It gives us knowledge on Solid-State Electronics, various types of Diodes and their circuits. To identify the type of electrical machines used for particular applications. Explains the working principles and parts of various electrical and electronic devices.

Course Outlines

Contents	**No of Lectures**
Unit-I Solid-State Electronics - Semiconductor materials and properties, charge carriers in solids, band gap energy, intrinsic and extrinsic semiconductors, transport of carriers, mobility and resistivity, drift and diffusion currents. Introductory knowledge to semiconductor devices processflow.	10
Unit-II Diodes - Band-structure of p-n junction, p-n junction in equilibrium, depletion region, built-in potential, p-n junction under reverse bias, junction capacitance, p-n junction under forward bias, I/V characteristics, reverse breakdown, Zener and avalanche breakdown. Ideal diode, p-n junction as a diode, temperature effects and breakdown voltages, Transition and diffusion capacitance of p-n junction diodes, diode models.	10
Unit-III Diode circuits - Half wave, full wave, bridge rectifiers, Capacitor, Inductor, L-section and π- section filters. Zener diode as voltage regulator, Linear wave Shaping- High pass, low pass RC circuits, their Response for Sinusoidal, Step, Pulse, Square, and Ramp inputs. Clipping and clamping circuits. Special Diodes- Tunnel Diode, IMPATT diode, Gunn diode, p-n-p-n diode, and Schottky diode.	10
Unit-IV Bipolar Junction Transistors and Biasing - PNP and NPN transistors, Characteristics of the current flow across the base regions, Minority and majority carrier profiles, Transistor as a device in CB, CE and CC configurations, and their characteristics. Biasing and Thermal Stability - The operating Point, DC and AC load lines, Fixed Bias, Collector Feedback Bias,	10

Emitter Feed Back Bias, Voltage divider Bias, Stabilization, stabilization circuits, Thermal runaway, and thermal stability.	
Unit-V Field-Effect Transistors - JFET and its characteristics, Pinch off voltage and drain saturation current. MOSFET - the MOS capacitor, n-channel enhancement-mode MOSFET - transistor structure, I-V characteristics, PMOS, MOSFET DC circuit analysis, basic MOSFET applications - switch, digital logic gate and amplifier, Biasing of FETs and MOSFETs.	10

Course Outcomes:

Upon successful completion of this course, candidates will be able to:

- Understand the working of diode and transistors
- Analyse the basic circuits using diodes and transistors
- Analyse the characteristics of various diodes, transistors and rectifiers
- Learn the importance of biasing of transistors

Text Books

1. Microelectronics Circuit Analysis and Design, Donald Neamen, McGraw Hill, 2010, 4th Edition.
2. Fundamentals of Semiconductor Fabrication, Gary S May ad Simon M Sze, Wiley, 2003, 1st Edition.

Reference Books

1. Electronic Devices and Circuit Theory, Robert L Boylestad and Louis Nashelsky, Pearson, 2013, 11th Edition.
2. Microelectronic Circuits: Theory and Applications, Adel S Sedra, K C Smith and A N Chandorkar, Oxford University Press, 2017, 7th Edition.
3. VLSI Technology, S M Sze, 2003, 2nd Edition.
4. Microelectronic Circuit Design, Richard C Jaeger and Travis N Blalock, McGraw Hill, 2016, 5th Edition.
5. Solid State Electronic Devices, Ben Streetman, Pearson, 2015, 7th Edition.

Electronic Devices and Circuits Laboratory

Course Code: BEECE1C002L

Course Title: Electronic Devices and Circuits Laboratory

Semester: I

Credits: 02

Rationale

To study and operate the basic electronic components and to observe the characteristics and behavior of the electronic devices.

List of Experiments:

1. Study of Instruments and components
2. V-I Characteristics of Si and Ge Diodes
3. Zener Diode Characteristics and Zener Diode as Voltage Regulator
4. Clippers and clampers
5. Half Wave and Full Wave Rectifiers
6. BJT Characteristics
7. FET Characteristics
8. BJT Biasing
9. FET Biasing
10. BJT as an Amplifier
11. UJT characteristics

Course Outcomes

Upon successful completion of this course, candidates will be able to:

- Plot the characteristics of semiconductor diodes and transistors to understand their behavior.
- Design, construct and test amplifier circuits and interpret the results.
- Operate electronic test equipment and hardware/software tools to characterize the behaviour of devices and circuits.
- Design and test the Diode clippers, clampers and rectifiers

Text Books

1. Microelectronics Circuit Analysis and Design, Donald Neamen, McGraw Hill, 2010, 4th Edition.

2. Fundamentals of Semiconductor Fabrication, Gary S May ad Simon M Sze, Wiley, 2003, 1st Edition.

Reference Books

1. Electronic Devices and Circuit Theory, Robert L Boylestad and Louis Nashelsky, Pearson, 2013, 11th Edition.
2. Microelectronic Circuits: Theory and Applications, Adel S Sedra, K C Smith and A N Chandorkar, Oxford University Press, 2017, 7th Edition.
3. VLSI Technology, S M Sze, 2003, 2nd Edition.
4. Microelectronic Circuit Design, Richard C Jaeger and Travis N Blalock, McGraw Hill, 2016, 5th Edition.
5. Solid State Electronic Devices, Ben Streetman, Pearson, 2015, 7th Edition.

Problem Solving and Computer Programming in C

Course Code: BEECE1C006T

Course Title: Problem Solving and Computer Programming in C

Semester: I

Credits: 04

Rationale

Solving problems is the core of computer science. Purpose of programming is to solve problems. Programmers must first understand how a human solves a problem, then understand how to translate this "algorithm" into something a computer can do, and finally how to "write" the specific syntax (required by a computer) to get the job done.

Course Outlines

Contents	**No. of Lectures**
Unit - I Fundamentals of Computers - Historical perspective, Early computers, Components of a computers, Problems, Flowcharts, Memory, Variables, Values, Instructions, Programs. Problem solving techniques - Algorithmic approach, characteristics of algorithm, Problem solving strategies: Top-down approach, Bottom-up approach, Time and space complexities of algorithms.	**10**
Unit - II Number systems and data representation - Basics of C, data types, tokens, keywords, variables, Numbers, Conditional statements - If-else, Switch-case constructs, Loops - while, do-while, for. Problems on Date and factorials, Solutions using flow of control constructs,	**10**
Unit -III Functions - Modular approach for solving real time problems, user defined functions, library functions, parameter passing - call by value, call by reference, return values, Recursion.	**10**
Unit - IV Introduction to Pointers and Arrays - Sorting and searching algorithms, Large integer arithmetic, Single and Multi-Dimensional Arrays, passing arrays as parameters to functions, Magic square and matrix operations using Pointers and Dynamic Arrays, Multidimensional Dynamic Arrays	**10**

Unit – V	10
String processing, File operations. Structures and Union, Declaration, member variables, member functions, access modifiers, Templates, Problems on Complex numbers, Date, Time, Large Numbers, factorials, number series and pattern generation.	

Course Outcomes

Upon successful completion of this course, candidates will be able to:

- Design algorithms for solving simple mathematical problems including computing, searching and sorting.
- Compare and contrast algorithms in terms of space and time complexity to solve simple mathematical problems.
- Explore the internals of computing systems to suitably develop efficient algorithms.
- Examine the suitability of data types and structures to solve specific problems.
- Apply control structures to develop modular programs to solve mathematical problems.
- Apply object oriented features in developing programs to solve real world problems.

Text Books

1. Problem Solving and Program Design in C by Jeri R. Hanly, Elliot B. Koffman; Pearson Addison-wesely, 2006.
2. Yashwant Kanetker, Let us C, BPB.
3. Balagurusamy, E., Programming in ANSI C, McGraw-Hill.
4. Computer Science- A Structured Srogramming Approach Using C by Behrouz A. Forouzan, Richard F. Gilberg; 3rd Edition(India Edition), 2007

References Books

1. How to Solve it by Computer, R.G. Dromey, Pearson, 2008.
2. Programming in ANSI C, E Balagurusamy, McGraw Hill Education, 8th Edition.
3. Object-Oriented Analysis and Design with Applications, Grady Booch, Robert Maksimchuk, Michael Engle, Bobbi Young Ph.D., Jim Conallen, Kelli Houston , Addison-Wesley Object Technology Series, 3rd Edition