upGrad | LIVERPOOL JOHN MOORES UNIVERSITY

MASTER OF SCIENCE IN COMPUTER SCIENCE

Three specialisations. One destination.

upGrad is an online education platform that enables individuals to develop their professional potential in the most engaging learning environment. Online education is a fundamental disruption to the traditional model and will be having a far-reaching impact. At upGrad, we work towards transforming this online education wave into a tsunami! We take a full-stack approach, by leveraging content, technology, marketing and services, to offer quality education at scale in partnership with corporates and academia.
This translates into rigorous industry relevant programs for individuals looking for a professional upgrade. In last 10 years, digital technology has had a profound impact on billions of lives and thousands of businesses in India and abroad. The pace of growth is only expected to increase further, as the $150 billion Indian IT industry is set to double its revenue in the next 10 years. This growth will be driven by new age digital products and services, which will create millions of new developer jobs. To address this industry need, we have designed a joint Master's in Computer Science, with IIITB & Liverpool John Moores University.

The program will prepare our learners to excel in this rapidly evolving technology landscape, by strengthening their core concepts in computer science and providing exposure to full stack development. Post this program, you will develop into an industry-ready Software Developer, ready to excel in your career.”

Our aim is simple: We strive to create high-impact, on-campus hands-on experiences that prepare students for meaningful and productive careers”.

Ronnie Screwvala
Co-founder & Chairman

Words From The Dean

Our outstanding faculty, curriculum and pedagogy ensures that our graduate programs are ranked among the best in the country. Our learners have been well received by the industry and have been placed with some of the leading companies in the IT industry.

We have partnered with upGrad to offer a rigorous, Executive PG Program in Software Development with seven specialisations in trending topics like in Full Stack Development, Blockchain Development, Big data and others - a unique and exciting combination of core Computer Science concepts, development principles and industry-led, hands-on application development experience. In this program, IIITB's experienced faculty will teach the core concepts of computer science along with important software development principles. Additionally, learners will get opportunities to work on industry-relevant projects and interact with industry experts through upGrad's strong industry network. The program has been designed keeping in mind that the future belongs to the software developers who can think and implement end-to-end.

"As an independent institution and a deemed university, IIITB collaborates with the IT industry, leading academic institutions abroad, eminent scientists and industry leaders to offer learners the best possible education."

Prof. S. Sadagopan

Dean - IIIT Bangalore

upGrad as a thought leader in emerging technologies

We have trained:

10K+
Data Scientists

2K+
Full Stack Developers

5K+
Machine Learning Engineers

1.5K+
Big Data Analysts

1K+
Blockchain Developers

Program Highlights

Dedicated Career Assistance

Receive 360 degree career support. Attend mock interviews with hiring managers, resume building workshops and career fairs. Interact with industry mentors.

Blended Learning

Learn with the ease and flexibility of recorded sessions as well as live sessions, designed to ensure a wholesome learning experience.

For the Industry, by the Industry

Learn from 30+ case studies and industry experts who mentor you throughout the program.

Exclusive Access

Gain free access to micro-courses in Data Science and Machine Learning.

3 Specialisations

Choose from 3 specialisations on the basis of your background and career aspirations and get the learning you want.

Personalised Mentorship

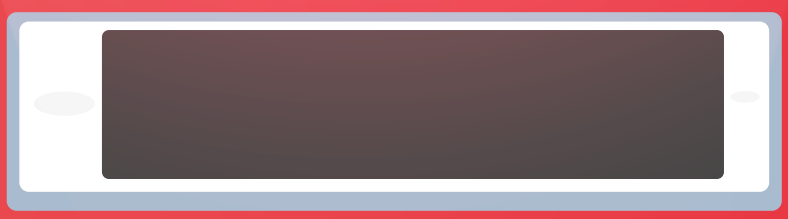
Get unparalleled personalised mentorship and doubt resolution from IIITB and LJMU's faculty and our panel of industry experts.

Dual Credentials from IIITB and LJMU

Pursue an Executive PG Program from IIITB & Master of Science in Computer Science from LJMU.

Get Alumni Status

Earn alumni status of IIITB & LJMU, with digital library access from LJMU.



Master's in Computer Science. How Does It Work

MASTER'S IN COMPUTER SCIENCE

EXECUTIVE PG PROGRAM IN SOFTWARE DEVELOPMENT
(Choice of Specialisation)

13 months | 110 credits

International Institute of Information Technology Bangalore

Next

After successful completion of Executive PG Program in Software Development from IIITB & upGrad.

RESEARCH METHODOLOGIES

2 months | 10 credits

MASTER'S DISSERTATION

4 months | 60 credits

Learn from Industry Experts

PROF. PAULO LISBOA
Head of Dept - Applied Mathematics,
LJMU

PROF. DHIYA AL-JUMEILY
Professor - Artificial Intelligence
LJMU

DR. ATIF WARAICH
Faculty - Computer Science
LJMU

DR. T K SRIKANTH
Professor - Computing
IIIT Bangalore

PROF. TRICHA ANJALI
Ex - Former Associate Dean
IIIT Bangalore

PROF. K V DINESHA
Professor
IIIT Bangalore

PROF. MEENAKSHI
Associate Professor
IIIT Bangalore

PROF. MURALIDHARA
Associate Professor
IIIT Bangalore

PROF. THANGARAJU
Professor
IIIT Bangalore

PROF. SUJIT
Assistant Professor
IIIT Bangalore

PROF. JAYAPRAKASH LALCHANDANI
Assistant Professor
IIIT Bangalore

PROF. R. CHANDRASHEKHAR
Dean (Academics)
IIIT Bangalore

Learn from Industry Experts

SHAKUN GUPTA
Founder and CTO
Slassy

VARUN SEHGAL
Director | Program Management
Zomato

CHENG-HAN LEE
Program Manager
ex-Microsoft

ANKIT MAHESHWARI
Tech Lead, Impact Running
ex-Housing

ABHIJEET SINGH
Sr. Engineering Manager
Microsoft

ASHUTOSH SHINDE
Engineering Manager
Inmobi

VISHWANATH PATTANSHETTI
Sr. System Analyst
ex-IBM

ROHAN KAPADIA
Software Developer
Swiggy and ex-Amazon

NOBAL MOHAN
Frontend Consultant
ex-Sportskeeda

SHILPA BHAT
Software Consultant
Vision Empower Trust

upGrad Learning Experience

A Truly International Program

Learn from international industry experts, global mentors and global career coaches. Get access to global job opportunities. Network with learners from 85+ countries.

Blended Learning

Learn with the ease and flexibility of recorded sessions as well as live sessions, designed to ensure a wholesome learning experience

Discussion Forums

Learn from your peers and teaching assistants, and for timely doubt resolution.

Industry-relevant Curriculum

Designed and taught by best in class industry experts, IIIT Bangalore and LJMU's faculty.

Re-learn the Concepts

Get program access for upto 3 years to refresh your concepts

Hands-On Projects

50+ case studies to choose from as well as a Capstone Project to apply learnings.

*Terms and conditions apply

360 degree Career Support by upGrad

- **Personalised Industry Mentorship**

Get mentored on the career front by an experienced professional of your desired domain and receive personalised feedback.

- **upGrad Sharp Interview Support**

Get company and role-specific preparation with mock interviews right before your actual interviews.

- **Resume Review**

Obtain specific, personalised inputs on your resume structure and content.

- **Career Mentor**

A dedicated career mentor to get alongside you in helping track your weekly company application targets, coach you on your profile and help you on your career transition journey.

- **Company-specific Preparation**

Get company-specific guidance with access to a carefully curated pool of interview resources per company to ensure that you're interview-ready for the company of your choice.

Industry Projects

Build a Social Q&A community like Quora

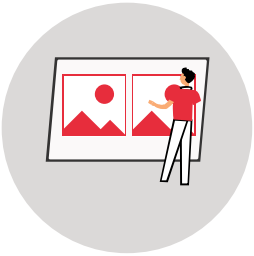


Image viewer web application like Instagram

Image uploader project like Imgur

Blogging website like blogger.com

Decentralised KYC process for banks

Land records and property registration

Supply chain & logistics

Drug traceability & patient data management- healthcare

Blockchain for cybersecurity

Retail banking

Build music recommendation systems

Curriculum

COMMON CONTENT

C0. PREPARATORY COURSE

FUNDAMENTALS OF PROGRAMMING LANGUAGE WITH BASIC DATA STRUCTURES (JAVA) — 2 WEEKS

- Learning the fundamentals of Java and its basic building blocks. Start with writing basic Java programs

C1. TOOLKIT FOR EXPERIENTIAL LEARNING

- **ABSTRACTION AND ENCAPSULATION** — 1 WEEK
  Understand & apply the concepts of Abstraction & Encapsulation in OOPs
- **INHERITENCE AND POLYMORPHISM** — 1 WEEK
  Understand & apply the concepts of Inheritance & Polymorphism in OOPs
- **ARRAYS, ARRAYLISTS, ENVIRONMENT SET UP** — 1 WEEK
  Learn about the data structure arrays and ArrayLists, perform some array operations & setup the environment for the upcoming modules
- **ASSIGNMENT (OPTIONAL)**
  Learn to apply your knowledge of OOP to build a simpler version of the Discussion Forum of upGrad platform that can run locally on your computer

C2. EXPERIENTIAL LEARNING

- **REQUIREMENTS IDENTIFICATION** — 4 WEEKS
  "Understand the requirements of a software product and think about the product's features & applications
- **ASSIGNMENT: REQUIREMENTS IDENTIFICATION** — 1 WEEK
  Design Mock UIs, create use-cases for various stakeholders within the application
- **DESIGN AND PROTOTYPING** — 1 WEEK
  Design and architect the blueprint of the product and create a prototype. Connecting all the different components within the product
- **ASSIGNMENT: DESIGN & PROTOTYPING (OPTIONAL)**
  Complete various methods, functions & features wrt to the application

- **MODULE LEVEL IMPLEMENTATION AND UNIT TESTING** — 1 WEEK
  Implement different components of the product, think of and design the flow between them, and find out of possible fault points in it. Perform Unit testing

- **ASSIGNMENT: MODULE LEVEL IMPLEMENTATION**
  Implement various modules within the application

- **INTEGRATION AND TESTING** — 1 WEEK
  Integrate different components of the product to make them work seamlessly. Ensure that any possible fault points are rectified through testing

C3. OOD + SOFTWARE ENGINEERING

- **SDLC AND AGILE METHODOLOGY** — 1 WEEK
  Introduction to Software Development Life Cycle and the various steps involved in the development of software. Learn about Agile methodologies in detail

- **OBJECT ORIENTED DESIGN** — 1 WEEK
  Understand the importance of Objected Oriented Design & UML Diagrams

- **TESTING AND VERSION CONTROL** — 1 WEEK
  Learn about unit testing i.e. testing individual units/components of a software, characteristics of Test-driven Development & Code Refactoring. Along with this you will also learn modern SE practices and skills and contribute to an existing software project or codebase using version control tools like Git

- **ASSIGNMENT - OOAD** — 1 WEEK
  Design a basic Food Ordering application from scratch using the concepts of SDLC, OOAD, TDD and version control taught in the course

C4. DATA STRUCTURES AND ALGORITHMS

- **ALGORITHM ANALYSIS + RECURSION** — 1 WEEK
  Learn about order of growth, Big-Oh, runtime + memory analysis, and time vs space tradeoff; Learn about algorithmic complexity of problems, and improve the efficiency of their implementations

- **SEARCHING AND SORTING (DIVIDE AND CONQUER INCLUDED)** — 2 WEEKS
  Learn about divide-and-conquer techniques such as merge sort and binary search

- **STACKS & QUEUES** — 1 WEEK
  Learn about Stacks & Queues and their applications

- **SETS AND DICTIONARIES (HASHTABLE, TREES AND BSTS, HEAPS)** — 2 WEEKS

  Understand the usage and application of various important data structures such as Hashtables, Trees, Binary Search Trees and Heaps. Learn about their interesting features, their utility and also find solutions of important problems related to these data structures

- **GRAPHS & GRAPH ALGORITHMS** — 1 WEEK

  Learn various applications and use cases of Graphs. Work on problems which require the application of Graph principles and also practice essential Graph related questions

- **MANDATORY ASSIGNMENT** — 1 WEEK

  An assignment based upon coding questions of all preceding topics

- **GREEDY, DYNAMIC PROGRAMMING - OPTIONAL** — 0 WEEK

  Learn about the greedy algorithm and how to use it to solve optimisation problems. Learn about dynamic programming, which is a popular technique to solve a particular kind of problem where you are required to find the best possible solution from a number of different solutions

Exam Week: Exam (Course 2, Course 3, Course 4) — 1 WEEK

- **INTERVIEW SKILLS** — 2 WEEKS

  Learn about the essential soft skills.(Resume Building, Linkedin Building, Networking, Job Interview Skills, Salary Negotiation, etc.) , Communication Skills (Critical Thinking, Business Writing, Confidence Building, Speaking, Listening, Art of Conversing, Business Etiquettes), etc

C5. CAREER TRANSITION BOOTCAMP (OPTIONAL)

- **ALGORITHM ANALYSIS + RECURSION**

  Learn about order of growth, Big-Oh, runtime + memory analysis, and time vs space tradeoff; Learn about algorithmic complexity of problems, and improve the efficiency of their implementations

- **SEARCHING AND SORTING (DIVIDE AND CONQUER INCLUDED)**

  Learn about divide-and-conquer techniques such as merge sort and binary search

- **STACKS & QUEUES**

  Learn about Stacks & Queues and their applications

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  An assignment based upon coding questions of all preceding topics

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Buffer Week

1 WEEK

FULL STACK DEVELOPMENT SPECIALIZATION

C6. USER INTERFACES & FRONTEND DEVELOPMENT

- **HTML & CSS** — 1 WEEK
  Learn how to create basic websites using HTML & CSS
- **JAVASCRIPT & DOM** — 2 WEEKS
  Learn the basics of JavaScript and DOM manipulation to create an interactive website
- **ADVANCED JAVASCRIPT** — 1 WEEK
  Learn the advanced concepts of JavaScript
- **AJAX & BACKEND INTEGRATION** — 1 WEEK
  Make REST API calls to the backend server and integrate the response accordingly to the front-end
- **WEB DEVELOPMENT FRAMEWORKS (REACT)** — 2 WEEKS
  Write applications using the React Framework and develop professional grade applications
- **ASSIGNMENT/PROJECT - FRONTEND** — 1 WEEK
  Creating the front-end of a blogging website using HTML, CSS and JavaScript

C7. BACKEND DEVELOPMENT

- **MULTITHREADING & STEAMS API** — 0 WEEK
  Learn about multithreading & Streams API
- **MVC ARCHITECTURE** — 1 WEEK
  Understand a popular software design architecture called MVC and implement MVC architecture using Spring MVC. Create the backend of a simple project using Spring Boot framework. Understand the basic concepts of Spring framework
- **DATA AND DATABASES IN APPLICATION DEVELOPMENT (JDBC, ORM)** — 3 WEEKS
  Learn how data and databases form an integral part of the application development. Also, understand the NoSQL databases
- **WEB BACKEND AND REST APIS (INTRODUCTION TO SPRING FRAMEWORK, ORM CONNECTION, REST API)** — 3 WEEKS
  Implement the REST API endpoints using the JPA specification and Spring Boot framework
- **ASSIGNMENT/PROJECT - BACKEND (GROUP)** — 1 WEEK
  Develop the backend for a Q&A website like Quora

Exam Week: Exam — 1 WEEK

Buffer Week — 1 WEEK

C8. SOFTWARE ARCHITECTURE AND DEPLOYMENT

- **DISTRIBUTED ARCHITECTURES** — 1 WEEK
  Learn about distributed systems, where the user load is distributed across various server systems, and learn different techniques to efficiently manage user traffic
- **DESIGN PRINCIPLES (SOLID) AND PATTERNS** — 2 WEEKS
  Get introduced to various principles, patterns and styles around which the architectures of a myriad of softwares revolve
- **MICROSERVICES ARCHITECTURE** — 1 WEEK
  Learn about Redis & Kafka, ORM L1 & L2
- **SYSTEM DESIGN** — 1 WEEK
  Understand what a typical full-stack web application system looks like
- **DEVOPS** — 1 WEEK
  Understanding of the process to be followed during the development of an application, from the inception of an idea to its final deployment. Learn about the concept of DevOps and the practices and principles followed to implement it in any company's software development life cycle
- **CLOUD-NATIVE DEPLOYMENT** — 1 WEEK
  Learn how to deploy an application on AWS using Jenkins as a CI/CD tool and following DevOps practices
- **ASSIGNMENT/PROJECT** — 1 WEEK
  Course Assignment/Project

Exam Week: Exam — 1 WEEK

Buffer Week — 1 WEEK

C9. CAPSTONE

- **CAPSTONE PROJECT (GROUP)** — 4 WEEKS
  The capstone project will stitch all the concepts learnt during the program

CYBER SECURITY SPECIALIZATION

C6. INFORMATION SECURITY AND APPLIED CRYPTOGRAPHY

- **INTRODUCTION TO CYBERSECURITY** — 1 WEEK
  Get introduced to Cybersecurity
- **OS FUNDAMENTALS AND SECURITY** — 2 WEEKS
  Linux CLI, Hardening, Bash Scripting and security in Linux
- **INFORMATION PROTECTION AND ENCRYPTION** — 1 WEEK
  Basic Information Protection: Data Secrecy/Confidentiality and Integrity - Requirements. Encryption as a Solution for Secrecy. Encryption vs Encryption as a computationally difficult to invert function, Symmetric and Asymmetric encryption techniques. Encryption vs Encoding
- **INTRODUCTION TO CRYPTOGRAPHY** — 1 WEEK
  Cryptography - Confusion and Diffusion Properties. Public Key and Private Key Encryption Techniques (RSA and AES as Examples). Password-based Encryption. HSM and PKI
- **CRYPTOGRAPHIC KEY MANAGEMENT** — 1 WEEK
  Key Management. Diffie Helman Key Exchange. Java Cryptography Architecture (JCA). Key Stores. Providers
- **MESSAGE DIGESTS AND DIGITAL SIGNATURES** — 1 WEEK
  Message Digests. Hashes and Signatures. Keyed Hashing. Digital Signatures. Digital signatures as Solutions for Sender Identity, Message Integrity and Non-repudiation
- **IDENTITY ACCESS MANAGEMENT** — 1 WEEK
  IDAM lifecycle, User Authentication: Passwords and Limitations. Challenge Response Protocols. Replay and Man-in-the-middle Attacks. Freshness / Currency. CAPTCHAS; Multi-factor Authentication; Oauth and OpenId
- **ASSIGNMENT/PROJECT - ACCESS CONTROL** — 1 WEEK
  Course Assignment/Project

C7. NETWORK SECURITY IN ETHICAL HACKING

- **INTRODUCTION TO NETWORK SECURITY AND SPOOFING** — 1 WEEK
  Local Area Networks - Switched Ethernet. Switches and Security. Addresses: MAC and IP addresses. Address Spoofing. ARP protocol and spoofing, SNMP and IGMP protocols, (SNMP, SNPP, SFTP, SSH protocol basics)
- **SECURED NETWORKS SYSTEM WITH FIREWALL** — 2 WEEKS
  Broadcast Domains and Isolation; Virtual LANs. Private vs. Public Addresses. Gateways. Network Address Translation. Demilitarized Zones (DMZs). Firewalls, Access Control, and Firewall Rules

- **PACKET INSPECTION AND ATTACK AGAINST AVAILABILITY** — 1 WEEK
  Packet Inspection, Deep Packet Inspection(Intrusions detection system and Intrusion Prevention System), IP Security, ICMP attacks. TCP and UDP Security. Attacking Availability: Denial-of-Service attacks, Distributed DOS attacks, SSL/TLS , IP Table
- **NETWORK ACCESS CONTROL** — 4 WEEKS
  Insider Attacks. Network Access Control. Proxy (Web) Servers. Forward proxy and reverse proxy
- **SIEM TOOLS AND ADDITIONAL SECURITY MEASURES** — OPTIONAL
  SIEM basics, Logs and Monitoring, Endpoint security measures
- **MALWARE THREATS AND ANALYSIS** — OPTIONAL
  Malware threat and analysis
- **ASSIGNMENT/PROJECT - INTRUSION DETECTION SYSTEM/EXPLOITING VIRTUAL MACHINE** — 1 WEEK
  Course Assignment/Project

Exam Week: Exam	1 WEEK
Buffer Week	1 WEEK

C8. APPLICATION SECURITY IN ETHICAL HACKING AND ADVANCED CONCEPTS IN CYBER SECURITY

- **INTRODUCTION TO APPLICATION SECURITY** — 1 WEEK
  Secure Programming. Information Flow and Security. Buffer Overflow Attacks. Managed Execution - JVM. OWASP top 10
- **WEB-BASED APPLICATIONS AND ASSOCIATED VULNERABILITIES** — 1 WEEK
  Web-based applications: Browsers and Browser Security, CSP Policies. Javascript vulnerabilities and Cross-Site Scripting. XSS and CSRF vulnerabilities
- **COOKIES AND TRACKING** — 1 WEEK
  Cookies and Tracking; User Identities and User profiling
- **DATA AND DATABASE SECURITY** — 2 WEEKS
  Data and Database Security - SQL Injection Attacks; Data access and Access Control, Access Control on views, Data Privacy and Anonymity
- **PHISHING AND OTHER ATTACKS ON IDENTITY** — 1 WEEK
  Phishing and other attacks on Identity(Social Engineering)

- **CLOUD APPLICATION SECURITY** — OPTIONAL
  Cloud application Security: DOS attacks on the cloud; Process security and Data Access - Protection against multi-tenancy; Isolation in VMs and Containers
- **MOBILE SECURITY** — OPTIONAL
  Android Security from Admin perspective
- **PENETRATION TESTING, FUZZING** — OPTIONAL
  Pentesting and tools, exploiting OWASP top 10 vulnerabilities in web application
- **REGULATION, COMPLIANCE, AND RISK MANAGEMENT** — 1 WEEK
  NIST, ISO 27001, GDPR
- **ASSIGNMENT/PROJECT - EXPLOIT WEB APPLICATION** — 1 WEEK

Exam Week: Exam	**1 WEEK**
Buffer Week	**1 WEEK**

C9. CAPSTONE

- **CAPSTONE PROJECT** — 4 WEEKS

CLOUD COMPUTING SPECIALIZATION

C6. DISTRIBUTED SYSTEMS AND CLOUD & DATABASES

- **INTRODUCTION TO DISTRIBUTED SYSTEMS** — 1 WEEK
  Understand the notion of Distributed Systems and learn about the various intricacies of Distributed Systems
- **INTRODUCTION TO CLOUD (USING AWS)** — 1 WEEK
  Get introduced to the cloud and learn about various cloud services, and there use cases. Understand the concept of virtualisation. Learn about the various intricacies involved in provisioning compute and storage resource on the cloud
- **SQL AND RELATIONAL DATABASE MANGEMENT SYSTEMS + 1 WEEK OPTIONAL** — 1 WEEK
  Get introduced the Relational Database Management System and learn about the techniques to module relational databases. Use SQL to perform various DML and DDL queries on the relational database
- **HANDS-ON WITH NOSQL - MONGODB + 1 WEEK OPTIONAL** — 1 WEEK
  Understand the notion of NoSQL Database, take a hands-on approach and learn to model and query using MongoDB
- **ASSIGNMENT/PROJECT - SCHEMA DESIGN** — 1 WEEK
  Design a data model for an application using both SQL and NoSQL Databases

C7. DESIGN & DEVELOPMENT OF MICROSERVICES

- **INTRODUCTION TO SPRING CORE & SPRING BOOT** — 1 WEEK
  Get introduced to Spring boot framework and learn to develop a hello world web-application using Spring-Boot framework
- **DATA ACCESS LAYER & SERVICE LAYER** — 1 WEEK
  Take a hands-on approach and learn about how to build data and service layer in your application
- **INTRODUCTION TO BACKEND ARCHITECTURE WITH MONOLITHIC APPROACH, SERVICE ORIENTED ARCHITECTURE** — 1 WEEK
  Get introduced to web application the various types of software backend architectures and learn about their use-cases and challenges
- **INTRODUCTION TO MICROSERVICES; DISCOVERY OF MICROSERVICES + DESIGNING APPLICATIONS USING MICROSERVICES[HLD]** — 1 WEEK
  Learn about Microservices and the use cases and challenges of the Microservices based architecture
- **INTRODUCTION TO REST & CONTROLLER LAYER** — 2 WEEKS
  Get introduced to REST and understand its various intricacies to develop REST APIs

- **AOP - ASPECT ORIENTED PROGRAMMING & APPLICATION SECURITY** — 1 WEEK
  Get introduced to Aspect-Oriented Programming. Learn about the various concepts of exception handling and application security
- **COMMUNICATION AMONG MICROSERVICES** — 1 WEEK
  Learn and implement various microservices communication techniques
- **NON-BLOCKING APPLICATION(MESSENING QUEUES) - KAFKA** — 1 WEEK
  Understand the need for messaging services and learn to integrate them into your application
- **ASSIGNMENT/PROJECT - APPLICATION DEVELOPMENT** — 2 WEEKS
  Use the concept learnt so far and work on a industry grade project

Exam Week: Exam	**1 WEEK**
Buffer Week	**1 WEEK**

C8. SERVERLESS DEVELOPMENT AND DEPLOYMENT OF CLOUD-NATIVE APPLICATIONS

- **INTRODUCTION TO LAMBDA/SERVERLESS ARCHITECTURE + SERVERLESS DEVELOPMENT COMPOSING MICROSERVICES** — 1 WEEK
  NOTE- CERTAIN TOPICS NEED TO GO OPTIONAL(+1 WEEK OF OPTIONAL CONTENT)
  Get introduced to serverless architecture and understand its pros-cons and industry use-case
  Learn to develop services using the serverless approach
- **WEB APPLICATION OPTIMISATION** — 1 WEEK
  Understand and implement various application optimisation techniques commonly used in the industry
- **MICROSERVCIES - DEBUGGING AND TRUOBLE SHOOTING** — 1 WEEK
  Learn and apply various strategies to debug a microservice-based application
- **INTRODUCTION TO SPRING CLOUD AND DEPLOYMENT** — 1 WEEK
  Get introduced to Spring Cloud and learn to deploy microservices-based applications using Spring Cloud
- **CONTAINERS VS. VMS. RESOURCE EFFICIENCY. DOCKERS AS CASE STUDY** — 1 WEEK
  Understand the notion of containers and their use cases. Learn about Docker and create Docker images of your application
- **CONCEPTS OF CLOUD DEPLOYMENT & DEPLYOMENT USING KUBERNETES & SERVERLESS DEPLOYMENT + 1 WEEK OPTIONAL** — 2 WEEKS
  Get introduced to serverless architecture and understand its pros-cons and industry use-case
  Learn to develop services using the serverless approach

- **CONCEPTS OF CLOUD DEPLOYMENT & DEPLYOMENT USING KUBERNETES & SERVERLESS DEPLOYMENT + 1 WEEK OPTIONAL** — 2 WEEKS
  Understanding the various intricacies involved in deploying a application in cloud.
  Learn to deploy a microservice-based application on Kubernetes.
  Learn to deploy a serverless application on the Cloud
- **DEPLOYING WEB APPLICATIONS WITH AWS ELASTIC BEANSTALK (OPTIONAL)** — 0 WEEK
  Learn about AWS BeanStack and deploy a web application using BeanStack
- **ASSIGNMENT/PROJECT - APPLICATION DEVELOPMENT** — 1 WEEK
  Deploying an application on the Cloud

Exam Week: Exam	1 WEEK
Buffer Week	1 WEEK

C9. CAPSTONE

- **CAPSTONE PROJECT (GROUP)** — 4 WEEKS
  The capstone project will stitch all the concepts learnt during the program

Master's:

01. COMPUTING SYSTEMS

- **LOCALITY OF REFERENCE** — 1 WEEK
  Introduction to C Programs: Types and Functions; Compiling and Running a C Program: Using gcc on Linux; Measuring Run time; Impact of locality on Running time: High level language features and examples Locality of Reference: Principles; Techniques of Design and Implementation in HLLs

- **MEMORY LAYOUT** — 1 WEEK
  Introduction to Addresses, Pointers, Arrays and Dynamic Allocation in C programs; Measuring / Tracking Stack and Heap Usage of C programs; Memory Layout (and Memory Interface) of C programs

- **COMPILING AND RUNNING A PROGRAM - BEHIND THE SCENES** — 1 WEEK
  Using linker and libraries in C programs (using gcc); Static Linking and Dynamic Linking: How to with gcc; Building a C library using gcc; Linking; Impact of Linking and Loading on C programs; Case Study

- **CATCHING & LOOP UNROLLING** — 1 WEEK
  Measuring the impact of (hardware) caching and cache page size on C programs; Redis and Memcache; Loop Unrolling; Measuring the impact of Loop unrolling on C programs (under different scenarios); Loop Unrolling Techniques; Limitations; Different Cache Structures

- **MULTI-THREADING** — 1 WEEK
  Multi-threaded Programming using POSIX Threads; Designing Multithreaded code; Measuring performance of multi-threaded code on multi-core systems (including the shared-cache effect); Multicore architecture; Caching in multicore architecture

- **FILE SYSTEM** — 1 WEEK
  Process scheduling, Memory management, I/O, File security, Interprocess communication, Distributed processing, Replication and consistency, Fault tolerance, Synchronization; Filesystems; System calls for getting file attributes and directory information; Traversing a file system; Measuring Disk locality effect (use recursive copy)

- **PERFORMANCE ASPECTS OF HTTP** — 1 WEEK
  Analyse and understand different code modules of a basic HTTP server and relate them to different functions; Identify and test performance aspects of a typical HTTP server; Modular structure of a HTTP server; Performance factors and bottlenecks; DNS concepts

- **SOCKET PROGRAMMING - FILE TRANSFER** — 1 WEEK
  Implement a server process that can listen on a port, receive requests from the client and respond accordingly

02. RESEARCH METHODOLOGIES

- **INTRODUCTION TO RESEARCH AND RESEARCH PROCESS** — 10 WEEKS
  What is research and what is its role in everyday life?; Importance of having a clear research objective; Differences between two common areas of research i.e. scientific and social research; Data, information and knowledge; Structure of the research proposal

- **RESEARCH DESIGN** — 10 WEEKS
  Research design and how it helps in proceeding with research problem; Different types of research; Components of research design - Research Methods, Sampling; Pyramid of evidence

- **LITERATURE REVIEWING** — 10 WEEKS
  The process of formulating a research question; Resources used for literature reviewing; How to do a literature review

- **RESEARCH PROJECT MANAGEMENT** — 10 WEEKS
  Essential techniques associated with Research Project Management - Project Planning, Work Breakdown Structure, Gantt Chart, Replanning

- **REPORT WRITING AND PRESENTATION SKILLS** — 10 WEEKS
  Writing the thesis report and the presentation of thesis report - Structure of the written thesis report and that of the video presentation; Citation methods and rules - Journal Paper, Conference Paper, Website, Video

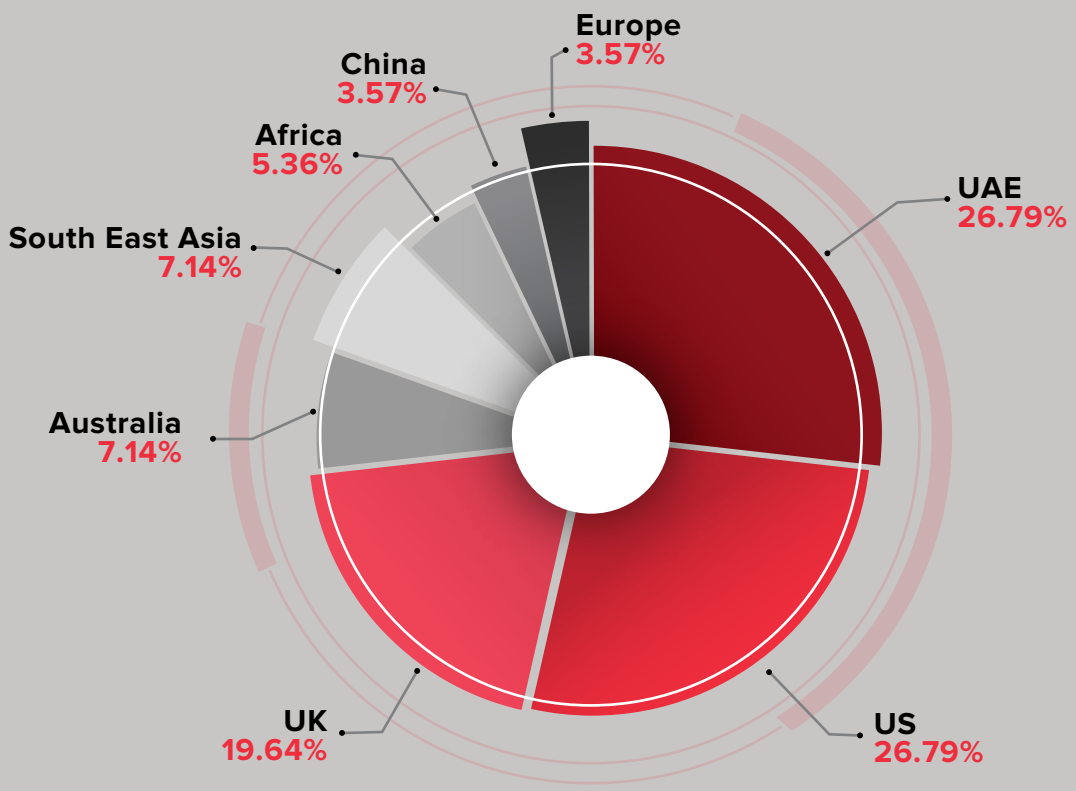
- **SCIENTIFIC ETHICS** — 10 WEEKS
  Different aspects of the scientific code of conduct and ethics - Copyrights and Intellectual Property, Professional Standards, Conflict of Interest, Professional Ethics and Collaboration in Research

03. THESIS

- **MASTER'S DISSERTATION** — 18 WEEKS
  A lengthy written study on some topic under upGrad's guidance, involving extended period of research and writing. The list of some sample research topics is as follows:-
  1. Investigate a diagnosis of eye diseases using imaging ophthalmic data
  2. Structure medical images with information geometry
  3. Using Social media feed to place tweets regarding natural disasters on a map
  4. Developing a recommender system for a Media giant
  5. Risk modelling for Financial activities and Investment Banking

Meet the Class

Opportunity to network with our international learners



Hear from our learners

Joel Varghese
Software Engineer,
Zoreum Blockchain Labs

The program has been very useful and my experience with upGrad and the student mentors at upGrad has been very good. The content taught is very relatable and the method of delivery is also convenient for working professionals like us"

Kriti Jain
Software Engineer,
Ministry of Defence

upGrad teaches complex topics in a very simple manner. The case studies are easily understandable and have added value to my resume and helped me bag a 125% salary hike. The curriculum is very relevant to today's market scenario and the upGrad team has done a good job in bringing education right at our palms "

Akshay Mathur
Software Technologist,
Philips

"The program has taught me a lot and the case studies have been very useful. The student mentors are very helpful and have helped me solve any and every problem that I have faced. It has been a great experience for me, I would definitely recommend the program to my friends. "

Kumar Shubham
SDET - II,
Blackbuck

"With upGrad, my experience has been wonderful. Managing work and studying has been the best decision of my life, thanks to upGrad. While it seemed difficult in the beginning, my student mentor helped me plan my schedule and manage time to maintain a work-life-study balance, which truly saved me! upGrad helped me gain a 60% salary hike "

Program Details & Admission Process

PROGRAM DURATION AND FORMAT
19 months | Online

PROGRAM FEE
Please refer to the website for program fee

PROGRAM START DATES
Please refer to the website for program start dates.

ELIGIBILITY
Bachelor's Degree with 50% or equivalent passing marks. No coding experience required.

WEEKLY COMMITMENT (upto 15 hours/week)

6-7 HOURS
Asynchronous learning time.

6-7 HOURS
Assignments and projects.

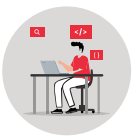
SELECTION PROCESS

STEP 1: Selection Test

Fill out an application and take a short 17-minutes online test with questions

STEP 2: Review and Shortlisting of Suitable Candidates

Our faculty will review all applications, consider the educational and professional background of an applicant and review the test scores wherever applicable. Following this, offer letters will be rolled out so you are assured a great peer group to learn and network with.



STEP 3: Enrollment for Access to Prep Content

Make a quick block payment with assistance from our loan partners where required, receive immediate access to the prep content and begin your upGrad journey.

For any queries, reach us on the following numbers:

+44 1224 980039 – Europe, Middle East and Africa

+1 (209) 850-4592 – North and South America

+65-3158-4368 – Asia Pacific except India

info.emea@upgrad.com

upGrad

Upgrad Edtech UK Limited
Eversheds House 70, Great Bridgewater Street,
Manchester, United kingdom - M1 5ES
Manchester UK