



School of Engineering
*Information
Technology Program*

ITP 356 – Blockchain: Decentralized Applications

Units: 4
Spring 2023

Lecture: TuTh 2:00pm-3:50pm
Location: THH 106

Instructor: Jack Boyuan Xu
Office: Remote
Office Hours: 1 hour after each class
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Teaching Assistant(s): Jordan Bettencourt, Gaurav Makasare, Dylan Patterson
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IT Help:
USC IT (ITS): <https://itservices.usc.edu/contact/>
Viterbi IT: <https://viterbi.usc.edu/resources/vit/contact-us.htm>

Catalogue Description

Learn the technical skills required to build decentralized applications on public blockchains. Applications that execute business transactions without the need of a trusted third-party.

Course Description

- Main components of a decentralized application (DApp)
- Social and design challenges to adoption of DApps
- Smart contracts written in the Solidity programming language
- Development environment required to write, test, and deploy an Ethereum DApp

Learning Objectives

After completing the course, students will be able to

- Explain what smart contracts and decentralized applications (DApps) are and the role they play in the Web 3.0 stack
- Comprehend the major technical, social, and economic implications of decentralized applications
- Develop smart contracts written in the Solidity programming language
- Develop a decentralized application with ethers.js, Truffle/Hardhat, etc.
- Deploy a decentralized application onto the Ethereum testnet

Prerequisite(s): ITP 256

Co-Requisite(s): None

Concurrent Enrollment: None

Recommended Preparation: <https://www.codecademy.com/learn/introduction-to-javascript>

Extra Course Information (MUST READ): <https://itp356.notion.site/Disk-A-3699117da3154219abe416263ee2db4c>

Course Notes

Lectures are delivered face to face in classroom when possible and over Zoom when COVID policies disallow in-person attendance. Lectures are Zoom-enabled and recorded. All course materials will be made available through Blackboard. These include:

- Lecture slides
- Homework Assignments
- Readings
- Software details and instructions
- Grades and feedback
- Office hours
- Online discussion forums on Piazza

Announcements made in class and content posted in Blackboard will supersede the contents of this syllabus.

Technological Proficiency and Hardware/Software Required

The assignments for this class will include both reading assignments as well as hands-on computer assignments. Students must bring their laptop computers to lecture sessions to participate in hands-on activities (loaner laptops are available for check out). Students will be given tutorials to gain familiarity with software tools.

VMware Player – Ubuntu Virtual Machine

If you are on Windows, it is recommended to utilize the provided Ubuntu VM to avoid environment setup issues. A VM image will be provided and VMware Player is needed. See Notion for additional installation instructions.

Required Readings and Supplementary Materials

Title: Mastering Ethereum

- Author/Publisher: Andreas Antonopoulos & Gavin Wood/O'Reilly Media
- ISBN-13: 978-1491971949
- <https://github.com/ethereumbook/ethereumbook>

Title: Ethereum Development Documentation

- Author/Publisher: Ethereum Community
- <https://ethereum.org/en/developers/docs/>

Title: Solidity Documentation

- Author/Publisher: Ethereum Community
- <https://solidity.readthedocs.io/en/develop/index.html>

In addition to the required reading and supplementary materials listed in the weekly breakdown section of this syllabus, additional materials will be announced in class and published on Blackboard.

Description and Assessment of Assignments

Homework: Most homework is computer based. Homework should be turned in to Blackboard or GitHub classroom on time. Grading will be based on completeness, accuracy, and timeliness. These are individual effort assignments. All homework assignments are due exactly before the beginning of class of the following week (e.g., an assignment due on Week 2 is due Week 1 Tuesday 3:59PM PST).

Exams are entirely open everything. However, no communication of any kind is permitted.

Grading Breakdown

Homework	29%
Programming basics quiz	1%
Midterm Exam	30%
Final Exam	40%
TOTAL	100%

Grading Scale

Course final grades will be determined using the following scale

A	93-100
A-	90-93
B+	87-89
B	83-86
B-	80-82
C+	77-79

C	73-76
C-	70-72
D+	67-69
D	63-66
D-	60-62
F	59 and below

Assignment Submission Policy

It is the responsibility of the student to make sure problem solutions and assignments are turned in on time. Make sure you follow the procedures outlined in each assignment (Blackboard submissions & GitHub Classroom).

Students are encouraged to work with their classmates. However, students must turn in their own, original work. Late homework submissions are NOT accepted due to in-class code reviews. You will be given a chance to correct your code after the review, but no additional points will be given if it is clear no effort was made before the code review.

Grading Timeline

Assignment grading will typically be completed 7 days after submission. Any exceptions will be announced in class or on Blackboard.

Additional Policies

The use of mobile devices or any communication software is not permitted during the exam. No make-up exams (except for documented medical or family emergencies) will be offered nor will there be any changes made to the Final Exam schedule, except as permitted by university rules.

Course Schedule (based on Spring semester weeks - subject to change):

	Topics/Daily Activities	Readings	Assignments
Week 1	Bitcoin Review & Ethereum Intro <ul style="list-style-type: none"> • Bitcoin Blockchain Review • What is Ethereum • Ethereum vs. Bitcoin <ul style="list-style-type: none"> ○ Philosophy ○ Account & State ○ Block Structure ○ Transaction & Gas ○ Applications 	<i>Mastering Ethereum, Chapters "What is Ethereum" & "Introduction" & "Keys and Addresses" & "Transactions"</i> https://bitcoin.org/bitcoin.pdf https://ethereum.org/en/whitepaper/ https://blog.ethereum.org/2015/11/15/merkle-in-ethereum/ https://ethereum.org/en/developers/docs/accounts/	HW0 assigned
Week 2	Smart Contracts, DApps, Web 3.0, Tokens <ul style="list-style-type: none"> • Smart Contracts • Ethereum Virtual Machine (EVM) • DApp vs. App • Web 3 vs Web 2 • Tokens on Ethereum 	<i>Mastering Ethereum, Chapters "Ethereum Basics", "Tokens"</i> http://www.ethdocs.org/en/latest/introduction/web3.html http://www.ethdocs.org/en/latest/introduction/history-of-ethereum.html	HW1 assigned
Week 3	Development Environment <ul style="list-style-type: none"> • State of Developer Tools • Web3 Base Layer Services • Deployment Tools • Smart Contract Tools • Remix IDE • Truffle & Hardhat • MetaMask • Local vs. Test vs. Main Network <p>Programming basics quiz</p>	<i>Mastering Ethereum, Chapters "Ethereum Testnets" & "Wallets"</i> https://github.com/EthereumCommunityFund/ethereum-ecosystem-map https://github.com/ConsenSys/DApp-ecosystem-map	HW0 due HW1 due HW2 assigned
Week 4	Solidity Language <ul style="list-style-type: none"> • Structure of a Contract • Variables, Types & Structs • Functions & Parameters • Visibility & Getters 	<i>Mastering Ethereum, Chapter "Smart Contracts"</i> https://solidity.readthedocs.io/en/develop/introduction-to-smart-contracts.html#a-simple-smart-contract	

Week 5	Solidity Programming I <ul style="list-style-type: none"> • Static vs. Dynamic State • Arrays & Memory Structure • Loops • Scoping and Declarations • Function Modifiers 	<i>Mastering Ethereum, Chapter “Dev Tools and Frameworks” & “Consensus”</i> https://solidity.readthedocs.io/en/develop/solidity-by-example.html	HW2 due HW3 assigned
Week 6	Solidity Programming II <ul style="list-style-type: none"> • Error Handling with Require, Revert • Conditionals • Events • Inheritance 	https://solidity.readthedocs.io/en/develop/solidity-in-depth.html http://www.ethdocs.org/en/latest/contracts-and-transactions/accessing-contracts-and-transactions.html	HW3 due HW4 assigned
Week 7	In-class HW3 & HW4 code review Midterm Exam		HW4 due
Week 8	Contract Deployment <ul style="list-style-type: none"> • Command Line • Setting up Truffle & Hardhat • Connecting Blockchain and Smart Contracts • Ethers.js • Local Network Deployment • Testnet Deployment 	http://www.ethdocs.org/en/latest/connecting-to-clients/index.html http://www.ethdocs.org/en/latest/contracts-and-transactions/developer-tools.html	HW5 assigned
Week 9	Contract Testing <ul style="list-style-type: none"> • Testing in TypeScript 	https://docs.ethers.io/v5/	
Week 10	Spring Break (not applicable to Fall)		
Week 11	Contract Security <ul style="list-style-type: none"> • Reentrancy • Race Conditions • Front Running • Timestamp Dependence • Over/Underflow In-class HW5 code review	https://solidity.readthedocs.io/en/develop/security-considerations.html https://consensys.github.io/smart-contract-best-practices/known_attacks/ https://solidity.readthedocs.io/en/develop/common-patterns.html https://solidity.readthedocs.io/en/develop/style-guide.html	HW5 due HW6 assigned
Week 12	Contract Optimization <ul style="list-style-type: none"> • Opcodes • Gas Efficiency 	https://docs.openzeppelin.com/contracts/4.x/	

Week 13	<p>In-class HW6 code review</p> <p>OpenZeppelin Library</p> <ul style="list-style-type: none"> • Ownable • Pausable • Upgradeable (Proxy pattern) <p>Creating your own token</p> <ul style="list-style-type: none"> • ERC20 • ERC721 	<p><i>Mastering Ethereum, Chapter "Ethereum Standards (EIPs/ERCs)</i></p> <p>https://docs.openzeppelin.com/contracts/4.x/tokens</p> <p>https://ethereum.org/en/developers/docs/standards/tokens/erc-20/</p> <p>https://ethereum.org/en/developers/docs/standards/tokens/erc-721/</p>	<p>HW6 due HW7 assigned</p>
Week 14	<p>Working with contract interfaces</p> <p>Decentralized decision making</p> <ul style="list-style-type: none"> • The rise of DAOs • Community governance <p>In-class HW7 workshop</p>	<p>https://consensys.net/blog/blockchain-explained/what-is-a-dao-and-how-do-they-work/</p> <p>https://ethereum.org/en/developers/docs/smart-contracts/anatomy/</p>	
Week 15	<p>Advanced topics</p> <ul style="list-style-type: none"> • Indexing the blockchain with The Graph • Using Chainlink Price Feeds • Storing data on IPFS • Alchemy Gateway <p>Web3 Infrastructures</p> <ul style="list-style-type: none"> • Gateways • Oracles • Indexing services • Decentralized file storage <p>In-class HW7 workshop</p>	<p>https://www.web3.university/article/what-is-a-node-provider</p> <p>https://chain.link/education/blockchain-oracles</p> <p>https://medium.com/graphprotocol/graphql-will-power-the-decentralized-web-d7443a69c69a</p> <p>https://docs.ipfs.io/concepts/what-is-ipfs/</p> <p>https://arweave.medium.com/what-is-arweave-explain-like-im-five-425362144eb5</p>	
Week 16	<p>Decentralized Application</p> <ul style="list-style-type: none"> • Degrees of decentralization • Sample DApps • Working with other EVM chains 	<p>https://polygon.technology</p> <p>https://www.avax.network</p> <p>https://www.bnbchain.world/</p> <p>https://fantom.foundation</p>	<p>HW7 due</p>
Week 17	<p>Final exam review</p> <p>Final Exam</p>	<p>Date: For the date and time of the final for this class, consult the USC <i>Schedule of Classes</i> at www.usc.edu/soc.</p>	

Statement on Academic Conduct and Support Systems

Academic Conduct

Plagiarism – presenting someone else’s ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in *SCampus* in Part B, Section 11, “Behavior Violating University Standards” <https://policy.usc.edu/scampus-part-b/>. Other forms of academic dishonesty are equally unacceptable. See additional information in *SCampus* and university policies on scientific misconduct, <http://policy.usc.edu/scientific-misconduct>.

Support Systems

Student Counseling Services (SCS) - (213) 740-7711 – 24/7 on call

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention. <https://engemannshc.usc.edu/counseling/>

National Suicide Prevention Lifeline - 1-800-273-8255

Provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week. <http://www.suicidepreventionlifeline.org>

Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-4900 - 24/7 on call

Free and confidential therapy services, workshops, and training for situations related to gender-based harm. <https://engemannshc.usc.edu/rsvp/>

Sexual Assault Resource Center

For more information about how to get help or help a survivor, rights, reporting options, and additional resources, visit the website: <http://sarc.usc.edu/>

Office of Equity and Diversity (OED)/Title IX Compliance – (213) 740-5086

Works with faculty, staff, visitors, applicants, and students around issues of protected class. <https://equity.usc.edu/>

Bias Assessment Response and Support

Incidents of bias, hate crimes and microaggressions need to be reported allowing for appropriate investigation and response. <https://studentaffairs.usc.edu/bias-assessment-response-support/>

The Office of Disability Services and Programs

Provides certification for students with disabilities and helps arrange relevant accommodations. <http://dsp.usc.edu>

Student Support and Advocacy – (213) 821-4710

Assists students and families in resolving complex issues adversely affecting their success as a student EX: personal, financial, and academic. <https://studentaffairs.usc.edu/ssa/>

Diversity at USC

Information on events, programs and training, the Diversity Task Force (including representatives for each school), chronology, participation, and various resources for students. <https://diversity.usc.edu/>

USC Emergency Information

Provides safety and other updates, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible, <http://emergency.usc.edu>

USC Department of Public Safety – 213-740-4321 (UPC) and 323-442-1000 (HSC) for 24-hour emergency assistance or to report a crime.

Provides overall safety to USC community. <http://dps.usc.edu>