PG-Curriculum
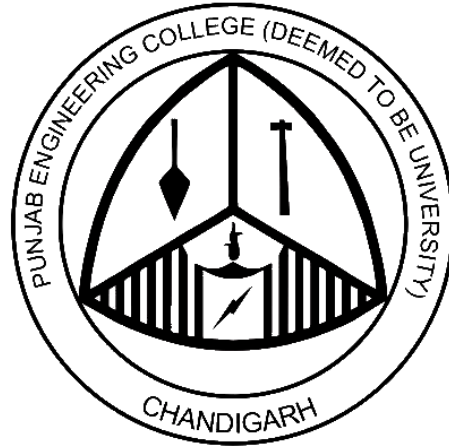**(Structure and Course Contents)**
Water Resources Engineering
With effect from July 2018

Civil Engineering Department
Punjab Engineering College
(Deemed to be University)
Chandigarh

Index

PG Curriculum Structure

Sr. No.	Course Stream	Course Name	Credits	When it runs in a semester					
				1	2	3	4	5	6
Semester I									
1.	Soft Computing	Internet of Things	1.5	▓	▓	▓			
		Machine Learning	1.5				▓	▓	▓
2.	Soft Skills and Management	Communication Skills (CS)	1.5	▓	▓	▓			
		Management and Entrepreneurship(M)/IPR	1				▓	▓	
		Professional Ethics (PE)	0.5						▓
3.	Program Core-I	Free Surface Flow	3	▓	▓	▓	▓	▓	▓
4.	Program Core-II	Advanced Fluid Mechanics	3	▓	▓	▓	▓	▓	▓
5.	Program Elective-I: E1	• Irrigation and Drainage Design • Hydro Power Engineering • Advance Soil Engineering	1.5	▓	▓	▓			
	Program Elective-II: E2	• Flood Control and River Training Works • Remote Sensing & GIS • Advance Engineering Geology	1.5				▓	▓	▓
6.	Engineering Mathematics (EM)	Engineering Mathematics- I (Fourier Transform)	1	▓	▓				
		Engineering Mathematics- II (Optimization techniques)	1			▓	▓		
		Engineering Mathematics- III (Numerical Analysis)	1					▓	▓
		Total Credits	**18**						

Sr. No.	Course Stream	Course Name	Credits	When it runs in a semester					
				1	2	3	4	5	6
Semester II									
1.	Design of experiments and research methodology	Design of Experiments and Research Methodology	3	▓	▓	▓	▓	▓	▓
2.	Program Core III	Advanced Hydrology	3	▓	▓	▓	▓	▓	▓
3.	Program Core-IV	Water Resources Planning & Management	3	▓	▓	▓	▓	▓	▓
4.	Program Elective-III: E3	• Fluvial Hydraulics • Design of Hydraulic Structures • Advanced Foundation Engineering	1.5	▓	▓	▓			
	Program Elective-IV: E4	• Ground Water Engineering • Bridge Engineering • Watershed Management • Embankment Dams	1.5				▓	▓	▓
5.	Open Elective	Design of Hydraulic Structures	1.5	▓	▓	▓			
		Ground Water Engineering	1.5				▓	▓	▓
6.	Mini project/ Pre-dissertation		3	▓	▓	▓	▓	▓	▓
		Total Credits	**18**						

Summer Term *

Sr. no.	Course Code	Course Name	Credits
1	CEN 601	Industrial Visit (3 days to 1 week of visit, Submission and presentation of visit report)	Satisfactory/ Non-satisfactory

*After Examination of second semester, in the first week of summer vacation industry visit can be undertaken.

Course No.	Course Name	Credits	When it runs in a semester					
			1	2	3	4	5	6
Semester-III								
1.	Dissertation/Industry Project	14						

Course No.	Course Name	Credits	When it runs in a semester					
			1	2	3	4	5	6
Semester-IV								
1.	Dissertation/Industry Project	18						

Total credits – 68

- *20% courses/ semester can be offered in blended mode MOOC's/Industry.*
- *MOOC's/Industry offered course is having fractional credits. Industry offering course content will be designed by industry will be as per expert availability. Industry person will deliver and evaluate this subject. As per the duration of MOOC's/industry offered course, credits of this course can be decided (fractional credits).*

SYLLABUS

Semester-I

Soft Computing

Course Name	:	Internet of Things
Course Code	:	SCM 5011
Credits	:	1.5
L T P	:	2-0-2
Segments	:	1-3

Total No. Lectures:-14
Total No. of Lab hours – 14

Course Objectives:

1. The student should be able to understand IoT architecture and market perspective. Also, student should be able to understand the basic principles and operation of different types of sensors commonly used on mobile platforms.

Course Contents:

S. No.	Course Contents	No. of Lectures
1.	**Introduction to IOT** What is IoT, how does it work? Difference between Embedded device and IoT device, Properties of IoT device, IoT Ecosystem, IoT Decision Framework, IoT Solution Architecture Models, Major IoT Boards in Market , Privacy issues in IOT	2
2.	**Setting Up Raspberry Pi/Arduino to Create Solutions** Explore Raspberry Pi, Setting up Raspberry Pi, Showing working of Raspberry Pi using SSH Client and Team Viewer, Understand Sensing actions, Understand Actuators and MEMS.	3
3.	**Communication Protocols used in IoT** Types of wireless communication, Major wireless Short-range communication devices, properties, comparison of these devices (Bluetooth, WIFI, ZigBee, 6LoWPAN), Major wireless Long-range communication devices, properties, comparison of these devices (Cellular IoT, LPWAN)	3
4.	**IoTApplications** IoT Applications for Value Creations Introduction, IoT applications for industry: Future Factory Concepts, Smart Grids , Brownfield IoT, Smart Objects, Smart Applications	3
5.	**Sensors** Applications of various sensors: Google Maps, Waze, WhatsApp, Ola Positioning sensors: encoders and accelerometers, Image sensors: cameras Global positioning sensors: GPS, GLONASS, IRNSS, Galileo and indoor localization systems, Motion & Orientation Sensors: Accelerometer,	3

| | Magnetometer, Proximity Sensor, Gyroscope, Calibration, - noise Modeling and characterization, and - noise filtering and sensor data processing, Privacy & Security, Selection of Sensors for Practical Applications | |

Lab Work:

S. No.	Lab contents	No. of Hours
1.	Setting up Raspberry Pi and Arduino	2
2.	Build small scale wireless communicating IOT device	4
3.	Integrate positioning sensors to IOT device	4
4.	Integrate motion and orientation sensors to IOT device	4

Course Outcomes:

At the end of the course, students will have:	
1	Understand the concept of IOT
2	Study IOT architecture and applications in various fields
3	Study the security and privacy issues in IOT.
4	Understand various applications of sensor in Industrial, healthcare, commercial, and building automation.

Bibliography:

S. No.	Name of Book/ Authors/ Publisher	Year of Publication/Reprint
1.	Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)", VPT, 1st Edition	2014
2.	Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", Apress Publications, 1st Edition	2013
3.	CunoPfister, "Getting Started with the Internet of Things", O-Reilly Media	2011
4.	Kyung, C.-M., Yasuura, H., Liu, Y., Lin, Y.-L., Smart Sensors and Systems, Springer International Publishing	2015

Course Name	:	Machine Learning
Course Code	:	SCM 5012
Credits	:	1.5
L T P	:	2-0-2
Segments	:	4-6

Total No. Lectures:-14

Total No. of Lab hours – 14

Course Objectives:

1. The students should be able to design and implement machine learning solutions to classification, regression and clustering problems; and be able to evaluate and interpret the results of the algorithms

Course Contents:

S. No.	Course Contents	No. of Lectures
1.	**Python** Introduction, Conditional Statements, Looping, Control Statements, String Manipulation, Lists, , Tuple, Dictionaries, Functions, Modules, Input-Output, Exception Handling	4
2.	**Supervised Learning** Linear Regression, Support Vector Machines, Decision Tree Learning	3
3.	**Unsupervised Learning** K-means, hierarchical clustering, principal component analysis, Neural Networks	4
4.	**Reinforcement and Control Learning** Introduction to reinforcement and control learning, Algorithms of control learning	3

Lab Work:

S. No.	Lab contents	No. of Hours
1.	A small scale gaming application	8
2.	Learn how to automate day-to-day tasks using Python.	6

Course Outcomes:

At the end of the course, students will have:	
1	Understand advantages and disadvantages of different machine learning algorithms
2	Identify suitability of machine learning algorithms for different domains

Bibliography:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/Reprint
1.	TanejaSheetal, Kumar Naveen, "Python Programming: A modular approach by Pearson", Pearson Education; First edition	2016
2.	Paul Barry, "Head First Python: A Brain-Friendly Guide",	2016

	Shroff/O'Reilly; Second edition	
3.	Tom M. Mitchell, "Machine Learning", McGraw Hill Education; First edition	**2017**
4.	Yuxi (Hayden) Liu, "Python Machine Learning By Example", Packt Publishing Limited	**2017**

Soft Skill & Management

Course Name	:	Communication Skills (CS)
Course Code	:	SSM 5021
Credits	:	1.5
L T P	:	0-1-4
Segments	:	1-3

Total No. Tutorials:- 07

Total No. of Lab hours:- 28

Course Objectives:

1. To enhance competence in communication skills: verbal and nonverbal.
2. To provide orientation in technical communication skills: spoken and written.
3. To sensitize students to attitude formation and behavioural skills.

Total No. Tutorials:- 07

S. No.	Course Contents	No. of Lectures
1.	**Introduction to Communication Skills, Soft Skills and Interpersonal Communication**	1
2.	**Speech:** Structure, Elements, Content, Organization and Delivery J-a-M	1
3.	**Writing Skills:** Letters, Minutes of Meeting	1
4.	**Technical Report Writing:** Concept & Structure	1
5.	**Research Writing:** Concept & Structural Framework	1
6.	**Power Point Presentation:** Project Presentation	1
7.	**Interviews**	1

Lab Work

S. No.	Lab. Contents	No. of Hours
1.	Self- Introduction	2
2.	Negotiation Skills & Role Play	2
3.	J-a-M Session	2
4.	Building Word Power through Reading	2
5.	Group Discussion and Case Study	4
6.	Writing Skills: Letters, Minutes of Meeting	2
7.	Technical Report Writing: Concept & Structure	4
8.	Research Writing: Concept & Structural Framework	4
9.	Power Point Presentation: Project Presentation	4
10.	Interviews	2

Course Outcomes

	At the end of the course, students will be able to
1	Enhance their competence in communication and technical communication and develop awareness of attitude formation and behavioural appropriateness.
2	The course will address the gap which exists between employer expectations and student proficiency.

Bibliography:

S. No.	Book Detail	Year of Publication
1.	Technical Communication, Meenakshi Raman and Sangeeta Sharma, Oxford University Press	2015
2.	English for Research Paper Writing, Adrian Wallwork, Springer, London	2011
3.	English Vocabulary In Use: Advanced+ CD, McCarthy Michael, CUP, Cambridge	2004
4.	Advanced English Grammar, Martin Hewings, CUP, Cambridge	2003
5.	Study Listening, Lynch Tony, CUP, Cambridge	2004
6.	Study Speaking , Anderson Kenneth, CUP, Cambridge	2010
7.	Study Reading , Glendenning H. Eric, CUP, Cambridge	2004
8.	Study Writing , Lyons Liz Hamp& Ben Heasley, CUP, Cambridge	2004
9.	Study skills in English, Michael J. Wallace, CUP, Cambridge	2004

Course Name	:	Management and Entrepreneurship/ IPR
Course Code	:	SSM 5022
Credits	:	1
L T P	:	0-3-0
Segments	:	4-5

Total No. Tutorials:- 14

Course Objectives:

1. The main aim of this course is to make students familiar with the concepts of Management and Entrepreneurship and understand how to develop new start-up and manage it effectively. It also aims to create awareness about the concepts of Innovation, Ideation and IPR.

Course Contents:

S. No.	Course Contents	No. of Tutorials
1.	Principles and Functions of Management	1
2.	Planning Process - Hypothetical Planning of an Event/Activity	1
3.	Form of Organization Structure - Case Study	1
4.	Human Resource Planning and Process, Current HR Practices	2
5.	Elements of Directing and Effective Control Mechanism Activity: Role Playing/Management Game	2
6.	Concepts of Entrepreneurship and Characteristics of Entrepreneurs	1
7.	Development Phases of Entrepreneurship -Idea Generation -Project Formulation and Validation -Business plan	4
8.	Ecosystem for Entrepreneurship Development and IPR	2

Course Outcomes

At the end of the course:	
1	The students will learn to develop and manage new project/start-up.
2	The students will be able to use management skills for success of business venture.

Bibliography:

S. No.	Book Detail	Year of Publication
1	"Entrepreneurship", TrehanAlpana, Dreamtech Press/Wiley India Publication.	2018
2	"Management Principles and Practice", Srinivasan R. and Chunawalla S.A., Himalaya Publishing House.	2017
3	"Essentials of Management: International and Leadership Perspective", WeihrichH.and Koontz H., 9th Edition, Pubs: McGraw Hill.	2012

4	"The New Era of Management", Daft R.L., 11th Edition, Pubs: Cengage Learning.	2014
5	"Principles & Practice of Management", Prasad L.M., 8th Edition, Pubs: Sultan Chand & Sons.	2015
6	"Management: Text and Cases", Rao V.S.P. and Krishna V.H., Pubs: Excel Books.	2008
7	"Management: Concept, Practice and Cases", Aswathappa K. and Ghuman Karminder, Pubs: McGraw Hill Education.	2010
8	"Dynamics of Entrepreneurial Development & Management", Desai V., 5th Edition, Pubs: Himalaya Publishing House.	2012
9	"Projects: Planning, Analysis, Selection, Financing, Implementation and Review", Chandra P., 8th Edition, Pubs: McGraw-Hill Education (India).	2014
10	"Entrepreneur's Toolkit", Harvard Business School, Pubs: Harvard University Press.	2004
11	"Essentials of Project Management", Ramakrishna K, Pubs: PHI Learning.	2010
12	Harvard Business Review: Entrepreneur's Handbook	2018
13	WIPO Annual Publications	

Course Name	:	Professional Ethics
Course Code	:	SSM 5023
Credits	:	0.5
L T P	:	0-3-0
Segments	:	6

Total No. Tutorials:- 07

Course Objectives:

1. The main aim of this course is to provide basic knowledge about ethics, values, norms and standards and their importance in professional life.

Course Contents:

S. No.	Course Contents	No. of Tutorials
1.	**Introduction to Ethics:** Concept of Ethics – Nature, Scope, Sources, Types, Functions and Factors influencing Ethics.	2
2.	**Self-Awareness & Self Development:** Concept of Self Awareness – Need, Elements, Self-Assessment – SWOT Analysis, Self-Concepts – Self-Knowledge, Assertiveness and Self-Confidence, Self-Esteem, Concept of Self-Development, Social Intelligence, Emotional Intelligence, Managing Time and Stress, Positive Human Qualities (Self-Efficacy, Empathy, Gratitude, Compassion, Forgiveness and Motivation	2
3.	**Ethics and Business:** Concept of Business Ethics – Nature and Objectives.Ethical dilemmas in business ethics.	1
4.	**Professionalism in engineering and its relation to ethics:** Ethics in Practice: Professional accountability, Roles of Professionals.	2

Course Outcomes:

At the end of the course:	
1	The students will be able to distinguish between right and wrong in both personal and professional life.
2	The students will learn about their strengths, weaknesses, opportunities & threats and work enthusiastically to transform weaknesses into strengths and threats into opportunities.

Bibliography:

S. No.	Book Detail	Year of Publication
1.	"Business Ethics – Text and Cases", Murthy C.S.V., 1st Edition, Pubs: Himalaya Publishing House.	2014
2.	"The Curse of Self: Self-awareness, Egotism and the Quality of Human Life", Leary M.R., 1st Edition, Pubs: Oxford University Press.	2007
3.	"Business Ethics", Hartman L.P. and Chatterjee A., 3rd Edition, Pubs: Tata McGraw Hill	2006
4.	"Business Ethics and Professional Values", Rao A.B., Pubs: Excel Books	2006
5.	"Business Ethics – Concepts and Cases", Velasquez M.G., 5th Edition, Pubs: Prentice Hall	2001
6.	"Issues and Ethics in the Helping Professions", Corey G., Corey M.S. and Callanan P., 8th Edition, Pubs: Brooks/Cole, Cengage Learning	2010
7.	"Theories of Personality", Hall C.S., Lindzey D. and Cambell J.B., 4th Edition, Pubs: Hamilton Printing Company	1997

Program Core

Course Name	:	Free Surface Flow
Course Code	:	CEM 5015
Credits	:	3
L T P	:	2-0-2
Segments	:	1-6

Total no. lectures/Tutorials- 28
Total No. of Lab Hours- 28

Course Objectives:

	The main Objectives of this course are:
1.	To understand the basic knowledge of free surface flow and its application in flood control
2.	To design of drainage ways and water ways.
3.	To enhance practical aspects of fluid flow in various hydraulic structures such as open channel, canal falls, hydraulic jump etc.

Course Content:

S. No.	Course Contents	No. of Lectures/Tutorials
1	**Introduction:** Free surface flows, velocity distribution, resistance relationships, specific energy and specific force, normal and critical depth computations, governing equation and computation of gradually varied flows.	**4**
2	**Uniform Flow in Mobile-Boundary Channel:** Incipient motion condition, regimes of flow, Resistance to flow in alluvial streams, non-scouring erodible boundary channels.	**5**
3	**Hydraulic Jump:** Elements of hydraulic jump, hydraulic jump in variety of situations including contracting and expanding geometries and rise in floor levels, control of hydraulic jump using baffle walls and cross jets.	**5**
4	**Spatially Varied Flows:** Flows past side weirs, De Marchi equations, design of side weirs, flow past bottom racks, trench weirs and waste water gutters.	**4**
5	**Unsteady Flows:** St. Venant's equations and their solution using method of characteristics and finite difference schemes; dam break problem, hydraulic flood routing.	**6**
6	**Channel Transitions:** Sub-critical and supercritical.	**4**

Lab Work:

Lab Contents		No. of Hours
1.	To study the velocity distribution in an open channel and to estimate the energy and momentum correction factors.	**2**
2.	To find the critical depth & surface profile using broad crested weir.	**2**
3.	To study the characteristics of a hydraulic jump for a constant and variable bed slope	**4**
4.	To study the boundary layer velocity profile and to determine the exponent in the power law of velocity distribution, boundary layer thickness and displacement thickness.	**4**
5.	Computation of Back Water and Draw Down Curves in a gradually varied flow	**4**
6.	Project related to mathematical and practical application of Free Surface Flow.	**8**
7.	Flow through transition in an open channel	**2**

8.	Design and analysis of side weir	**2**

Course Outcomes:

At the completion of this course, students will be able to:	
1.	Apply the concepts in various applications in canal & storage structures.
2.	Design of hydraulic structures on the basis of evolved practical relationships and analysis.
3.	Proficient enough to apply the concept of flow measurement in River & Channels along with Dam break analysis.

Bibliography:

S. No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1	"Open Channel Hydraulics", Chow, V.T., McGraw Hill.	2017
2	"Open-Channel Flows", Chaudhary, M.H., Prentice-Hall.	1994
3	"Flow Through Open Channels", Ranga Raju, K.G., Tata McGraw Hill.	2003
4	"The Hydraulics of Open Channel Flow: An Introduction", Chanson, H., Elsevier.	2004
5	"Open-Channel Hydraulics", French, R.H., McGraw-Hill.	1994
6	"Air entrainment in free-surface flows", Wood, I.R., Balkema.	1991

Course Name	:	Advanced Fluid Mechanics
Course Code	:	CEM 5025
Credits	:	3
L T P	:	2-0-2
Segments	:	1-6

Total no. lectures- 28
Total No. of Lab Hours- 28

Course Objectives:

	The main Objectives of this course are:
1.	To learn the basic concept of fluid mechanics and to impart knowledge of kinematics of different types of flows.
2.	To introduce the governing equations, laminar flow, turbulent flow and measurements of turbulence.
3.	To learn the concept of boundary layer formation in laminar and turbulent flow on different boundary shape.

Course Content:

S. No.	Course Contents	No. of Lectures/Tutorials
1	**Kinematics of Flow:** Equation of continuity in Cartesian, polar and cylindrical coordinates, rate of deformation, dilation, vorticity	**3**
2	**Standard 2D Flow Patterns:** Source, sink, doublet and their combinations, construction of flows by superposition, D. Alembert's paradox.	**3**
3	**Laplace Equation:** Solution by graphical and relaxation methods, conformal mapping, solution by separation of variables.	**3**
4	**Laminar Flow:** Derivation of Navier-Stokes equations, exact solutions for flow between parallel plates, Couette flow, flow near a suddenly accelerated plate and an oscillating plate.	**5**
5	**Boundary Layers:** Similarity solutions of boundary layer equations, Falkner-Skan Wedge flows, Karman's momentum integral equations, Karman – Puhlhausen approximate solution, separation in boundary layer under adverse pressure gradient, turbulent boundary layer.	**5**
6	**Turbulent Flows:** Reynolds equations of motion, semi-empirical theories of turbulence, velocity profiles for inner, outer and overlap layers, equilibrium boundary layers.	**5**
7	**Measurement of Turbulence and Statistical Theory of Turbulence:** Isotropic and homogeneous turbulence, probability density functions, correlation coefficients, decay of isotropic turbulence.	**4**

Lab Work:

S. No.	Lab Contents	No. of Hours
1.	To find the Drag Coefficient of flow past a cylinder	**2**
2.	To study the boundary layer velocity profile and to determine the exponent in the power law of velocity distribution, boundary layer thickness and displacement thickness.	**4**
3.	To study on Fall Velocity of an objects & to develop a relationship b/w coefficient of drag and Reynolds number.	**3**

4.	Energy Loss in Bends	**3**
5.	Analysis of Distribution Network using related software	**4**
6.	Project related to mathematical and practical application of fluid flow problems	**8**
7.	Flow visualization techniques in fluid flow	**2**
8.	To determine the gross characteristics of a submerged jet	**2**

Course Outcomes:

At the completion of this course, students will be able to:	
1.	Possess skills to take up research activities involving fluid mechanics.
2.	Apply the learned techniques in real life problems related to fluid mechanics.
3.	Analyze flow field in a variety of practical situations without going for physical model setup.

Bibliography:

S. No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1.	"Fluid Mechanics", White, F.M., McGraw-Hill.	2015
2.	"Boundary Layer Theory", Schlichting, H., McGraw-Hill.	2014
3.	"Turbulent Flow", Garde, R.J., Wiley Eastern.	1994
4.	"Turbulent Flows", Pope, S. B., Cambridge University Press.	2000
5.	"Fluid Mechanics", Ojha, C.S.P., Berndtsson, R. and Chandramouli, P.N., Oxford University Press.	2010
6.	"An Introduction to Turbulent Flow", Mathieu. M.J., and Scott, F., CUP Publisher.	2000

Classical Books:

S. No.	Name of the Book/Authors/Publishers	Year of Publication/ Reprint
1.	"Advanced Mechanics of Fluids", Rouse, H., John Wiley.	1959
2.	"Foundation of Fluid Mechanics", Yuan, S.W., Prentice Hall	1967

Program Elective

Course Name	:	**Irrigation & Drainage Design**
Course Code	:	**CEM 5121**
Credits	:	**1.5**
L T P	:	**2.5-0-2/2**
Segments	:	**1-3**

Total no. lectures: 17
Total Lab Hours: 04

Course Objectives:

	The main Objectives of this course are:
1.	To introduce the basic concepts of Irrigation engineering and its use in crop production with the help of canal network system including drainage aspects.
2.	To expose the importance of irrigation and drainage practices and management to students
3.	To learn about distribution systems for canal irrigation, and how to measure soil moisture in field

Course Contents:

S. No.	Course Contents	No. of Lectures
1	Available water Resources & Their Present Utilization	**2**
2	Soil water plant Relationship & Soil Fertility, Water Requirements of crops	**3**
3	Consumptive use, Estimation of Consumptive use	**4**
4	Frequency of Irrigation, Irrigation methods, management of Irrigation systems	**4**
5	Irrigation works, Water Logging, Drainage, Design of Drainage Systems, Case study on Water Management and Drainage system, Hooghoudt, Kirkham, Dagan and Ernst equations.	**4**
6	To check volumetric moisture content across various points in campus using Digital TDR.	**2**
7	To measure the infiltration by using double ring infiltometer.	**2**

Course Outcomes:

At the completion of this course, students will be able to:	
1.	do assessment of crop water requirement
2.	do optimum scheduling of irrigation
3.	do management of salinity problems and leaching process

Bibliography:

S. No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1	"Irrigation Engineering" by Bharat S., Nem Chand & Bros.	2005
2	"Irrigation Theory & Practice", by Michael, A.M, Vikas Publishing House, New Delhi.	2009
3	"Irrigation Water Management", by Majumdar, D.K., PHI Learning	2014
4	"Irrigation and Drainage Engg.", Waller, P., and Yitayew, M., Springer	2016

Classical Books:

S. No.	Name of the Book/Authors/Publishers	Year of Publication/ Reprint
1.	"Irrigation Engineering", Zimmermann, B.	1996

MOOC'S on this course are available at:

1. http://onlinecourses.nptel.ac.in/noc18_ar07/preview
2. https://www.mooc-list.com/tags/irrigation-techniques

Course Name	:	Hydro Power Engineering
Course Code	:	CEM 5122
Credits	:	1.5
L T P	:	2.5-0.5-0
Segments	:	1-3

Total no. lectures: 17
Total no. of Tutorials: 04

Course Objectives:

	The main Objectives of this course are:
1.	To impart knowledge related to fundamentals of hydropower Engineering.
2.	To enhance knowledge related to transient analysis and various component of a hydropower plant.
3.	To sensitize knowledge related to water hammer and surge phenomenon in hydro power generation

Course Contents:

S. No.	Course Contents	No. of Lectures
1	**Water Power:** Introduction, sources of energy, role of hydropower in a power system	2
2	**Estimation of Water Power Potential:** Flow duration curves of gauge and ungauged streams, load curve, load factor, capacity factor, utilization factor, diversity factor, load duration curve, firm power, secondary power, prediction of load. **Design and Analysis:** To procure hydrological data of a river basin and to analyze it for estimation of primary and secondary power.	3
3	**Types of Hydro-power Plants:** Run of river plants, general arrangement of run of river plants, valley dam plants, diversion canal plants, high head diversion plants, storage and pondage, pumped storage power plants.	2
4	**Penstocks:** General classification, design criteria, economical diameter, losses, anchor blocks, valves, bends and manifolds.	2
5	**Trash racks:** Types, losses, design, stability.	2
6	**Intakes:** Types, losses, air entrainment, anti-vortex device, air vent, power channels, forebay, and tunnel.	2
7	**Turbines:** Introduction, types of turbines, hydraulics of turbines, velocity triangles, draft tubes, cavitation in turbines, turbine model testing, characteristics of turbines.	2
8	**Water Hammer and Surges:** Introduction, water hammer, transients caused by turbine, load acceptance and rejection, resonance in penstocks, surge tanks, channel surges.	2

Course Outcomes:

	At the completion of this course, students will be able to:
1.	Solve the hydropower related problems arising in real life situation.
2.	Estimation of water power potential and hydraulic design of Hydro Power
3.	Analyze the water hammer and surge phenomenon in hydro power generation.

Bibliography:

S. No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1.	"Water Power Engineering", Dandekar, M.M., and Sharma, K.H., Vikas Publishing House Pvt Ltd.	2016
2.	"Hydro Power Structures", Varshney, R.S., Nem Chand & Bros.	2001
3.	"Hydro Electric Engineering", Nigam, P.S., Nem Chand & Bros.	2001
4.	"Applied Hydraulic Transients", Choudhary, M.H., Van Nostrand Reinhold Company	2014
5.	"Fluid Transients", Streeter, V.L., and Wylie, B., McGraw-Hill Book Company.	2013
6.	Norwegian Institute of Technology: Hydropower Development: Vols. 3, 4, 5 & 6, Division of Hydraulic Engineering.	1992-93

Classical Books:

S. No.	Name of the Book/Authors/Publishers	Year of Publication/ Reprint
1.	"Water Power Engineering", Barrows, H.K., Tata McGraw Hill Publishing Company Ltd.	1980
2.	"Hydropower Engineering", Warnick, C.C., Prentice-Hall.	1984

MOOC'S on this course are available at:

2. **https://www.mooc-list.com/tags/hydropower**

Course Name	:	Advanced Soil Engineering
Course Code	:	CEM 5123
Credits	:	1.5
L T P	:	2-0-2
Segments	:	1-3

Total No. of Lectures: 14
Total No. of Lab Hours: 14

Course Objectives:

The main objectives of the course are:	
1.	To impart knowledge of engineering properties of various types of soils.
2.	To impart knowledge of latest trends in soil engineering.

S. No.	Course contents	No. of Lectures
1.	**Origin, nature and distribution of soils:** Engineering Behaviour of Soils of India: Black cotton soils, alluvial silts and sands, laterites, collapsible and sensitive soils, aeolin deposits	2
2.	**Consolidation:** One, two and three dimensional and radial consolidation. Factors affecting shear behaviour. Determination of parameters. Pore-pressure parameters. Unconsolidated Undrained, Consolidated Undrained, Consolidated Drained tests. Total and effective stress paths.	3
3.	**Geosynthetics:** Types and functions; Principles of soil reinforcement; Design and construction of geosynthetic reinforced soil retaining structures, Geosynthetics in Pavements; separations, drainage and filtering in road pavements.	3
4.	**Methods of site investigations:** Direct methods, semi-direct methods and indirect methods. Field tests: In-situ shear test, in-situ permeability test, Standard Penetration Test, Dynamic Cone Penetration Test, Codal provisions.	3
5.	**Slope Stability analysis:** Finite and infinite slopes, limit equilibrium methods. Bishop (Rigorous and Simplified) Method	3

Lab Work:

Sr. No.	Lab contents	No. of Hours
1.	Consolidation Test	06
2.	Tri-Axial Test (UU, CU & CD)	06
3.	Demonstration of Static Penetration Test and Dynamic Cone Penetration Test	02

Course Outcomes:

	At the completion of the course, students will be able to:
1.	Ascertain the behaviour of soil as a construction material as supporting medium.
2.	To apply latest trends of soil engineering in construction.

Bibliography:

Sr. No.	Name of Book/Authors/Publisher	Year of Publication/ Reprint
1.	Soil Mechanics,Lambe and Whitman,Wiley Interscience Publication, New Jersey	2000
2.	Reinforced soil and its engineering application, Swami Saran, I.K. International, New Delhi	2013
3.	Physical and geotechnical properties of soils,Bowles, McGraw Hill Education, New York	1984
4.	Design aids in soil mechanics and foundation engineering,Kaniraj S.K.,McGraw Hill Education, New York	2017

Classical Books:

S. No.	Name of Book/Authors/Publisher	Year of Publication/ Reprint
1.	Soil Mechanics in Engineering Practice, Terzaghi and Peck, John Wiley and Sons, New Jersey	1948
2.	Soil Engineering, Alam Singh, CBS Publishers, New Delhi	2009

MOOCs on this course are available at:

1) http://nptel.ac.in/courses/105101001/
https://swayam.gov.in/courses/4386-soil-mechanics-geotechnical-engineering-i

Course Name	:	Flood Control & River Training Works
Course Code	:	CEM 5221
Credits	:	1.5
L T P	:	2 1 0
Segments	:	4-6

Total no. lectures: 14
Total No. of Tutorials: 07

Course Objectives:

	The main Objectives of this course are:
1.	To study the flood flow & its prevention by using hydraulic structures.
2.	To design the flood control structure and excess flood prevention
3.	To get acquainted with the guidelines for planning and design of river training works.

Course Contents:

S. No.	Course Contents	No. of Lectures
1	Alluvial streams and their hydraulic geometry, bed level variation of alluvial streams, variation in plan form of alluvial streams	2
2	Analytical models of river morphology, Numerical models for morphological studies, flood plain analysis and morphology of some Indian rivers.	2
3	Computational of peak floods, flood frequency analysis **Case Study:** To analyze peak flood using hydrological data of a watershed and visit to Water Resources Engineering Department	2
4	Floods in major Indian river basin, types and design of flood forecasting and protection systems and basic software's for flood modeling and forecasting.	2
5	Operational hydrology, reservoir operation for flood control and management, flood damage estimation models.	2
6	Guide lines for planning and design of river training works and maintenance of river training works and bank protections for alluvial rivers.	2
7	Application of Geo- synthetics in river training works.	2

Course Outcomes:

At the completion of this course, students will be able to:	
1.	Analyze the peak floods of given basin.
2.	Get clear understanding of flood damage estimation models.
3.	Develop the basic concepts of flood forecasting

Bibliography:

S. No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1.	BIS 107051(1994), 12094 (2000), 12926 (1995), 8408 (1994)	-
2.	"Mechanics of sediment transportation and alluvial streams problems", Garde R J and Ranga Raju K G , New age International Limited Publishers, New Delhi	2000
3.	"River Morphology", Garde R J , New Age International Publishers, New Delhi	2006
4.	"Hydraulic Design Handbook", Mays Larry W., Mc Graw Hill Companies, New Delhi	1999
5.	"Applied Hydrology" Mutreja K.N. Tata McGraw-Hill Publishing company Ltd., New Delhi	1990
6.	"Elementary Hydrology", Singh Vijay. P, Prentice Hall, India	1992

Classical Book

S .No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1.	"Applied Hydrology", Chow V T, Maidment David R and Mays Larry W, McGraw-Hill Book Company, New Delhi	1988

MOOC'S on this course are available at:

1. https://www.nptel.ac.in/courses/10S10S110/38

Course Name	:	Remote Sensing & GIS for Water Resources Engineering
Course Code	:	CEM 5222
Credits	:	1.5
L T P	:	2.5-0.5-0
Segments	:	4-6

Total no. lectures: 17
Total No. of Tutorials: 04

Course Objectives:

	The main Objectives of this course are:
1.	To Enhance the concepts of digital mapping
2.	To sensitize the concepts of remote sensing & GIS
3.	To make the students aware of recent advancements/software in surveying like Remote sending, digital photogrammetric, GIS, DIP etc.

Course Contents:

S. No.	Course Contents	No. of Lectures
1	**Modern Trends in Surveying and Mapping:** Digital Mapping, Uses and applications, data collection techniques (Conventional and Non-conventional), Present Status in India and abroad	2
2	**Aerial Photogrammetry** Introduction, types, Stereoscopy, Scale of a photograph, flight planning, Mosaics	2
3	**Geographical Information System (GIS)** Introduction, advantages, objectives of GIS, Definitions of GIS, Components of GIS, Overlay analysis, Digital Terrain Modeling, Digital Elevation Model Applications of GIS in various engineering fields, Four M's, Elements of Image visualization	2
4	**Introduction to Remote Sensing (RS) in Water Resources Engineering** Introduction, EM spectrum, Ideal RS System, Real RS System, Visual Image interpretation, active and passive remote sensing, Reflectance; spectral reflectance of land covers; Spectral characteristics of solar radiation; energy interaction in the atmosphere; energy interactions with the Earth's surface, Spectral reflectance curves, Resolution	3
5	**Digital Image Processing (DIP) applicable in Water Resources Engineering** Introduction, Histogram and image statistics, Remote Sensing Image distortion and rectification: Radiometric errors and Geometric errors. Image Enhancement techniques, Image classification – Supervised and Unsupervised classification, Formats	2
6	**Global Positioning System** Introduction, GPS, DGPS, Applications in Water Resources Engineering	2
7	**Smart City & Geospatial Technology** Introduction, Applications of GIS/RS in smart city and in Water Resources Engineering	1
8	**Software demonstrations and working** GIS/RS software	3

Course Outcomes:

At the completion of this course, students will be able to:	
1.	Enhance the knowledge related to recent advancements in surveying
2.	Understand various terms in Geospatial Industry and relate with applications of RS/GIS in Smart City initiatives and in water resources field
3.	Acquire skills in advance techniques such as hyper spectral, thermal and LiDAR scanning for mapping, modeling and monitoring

Bibliography:

S. No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1	"Geomatics Engineering", by Manoj Arora and R C Barjatiya, Nem Chand Brothers, Roorkee.	2011
2	"Principles of GIS", by Peter A. Burrough, Rachael A., Oxford University Press	2014
3	"Remote Sensing and Image Interpretation", by Lilysand T.M., and Kiefer R.W, Wiley Publishers	2010
4	"Introduction to GIS", by Kang-tsung Chang, Tata McGraw Hill, 5th Edition	2016
5	"Introduction to Remote sensing", by Campbell & Wynne, Guilford Press	2014
6	"Essential Image Processing and GIS for Remote Sensing", Liu, J.G., and Mason, P., Wiley	2009
7	"Integration of remote sensing & GIS", Victor, Wiley	2007

MOOC'S on this course are available at:

1. **https://onlinecourses.nptel.ac.in/noc17-ce1S/preview**

2. **https://ww.courseera.org/lecture/gis-applications/remote-sensing**

Course Name	:	Advanced Engineering Geology
Course Code	:	CEM 5223
Credits	:	1.5
L T P	:	2 0 2
Segments	:	4-6

Total no. lectures- 14
Total Lab Hours-14

Course Objectives:

	The main Objectives of this course are:
1.	To enhance megascopic and microscopic knowledge of mineral and rocks in turn.
2.	To importance of Geomorphic principles operated in the past, aerial photo-interpretation and its use in identification of different Landforms
3.	To understand significance of Landslides and Structural features in engineering construction. Critically examine role of Geological considerations in Civil Engineering Structures.

Course Contents:

S. No.	Course Contents	No. of Lectures
1	**Mineralogy and Geo-mechanics:** Important rock forming minerals, their megascopic and Microscopic properties. Outline classification, mode of formation & occurrence of important Rock groups (Sedimentary, Igneous and Metamorphic).	**3**
2	**Geomorphology:** Principles of geomorphology, occurrence of ground water in different rock types. Geo-photo interpretation of Aerial photograph. Application in highway planning and water resources field, Analysis of land forms, soil types, vegetative cover, Land forms (glacial, arid and fluvial), Snow cover features from aerial photographs.	**4**
3	**Engineering Problems:** Landslides: cause, classification, zonation and protection, subsidence and related phenomenon, structure of rocks (folds, faults, joints, and unconformity) and their significance in Engineering construction, foundation problems in different types of rocks. Geological considerations related to water Resources Engineering in the selection of site for dams, reservoirs, tunnels, abutments, buildings and air fields. Sensor driven/controlled dams/tunnels. Road stones and suitability of various rocks for road use.	**7**

Lab Work:

S. No.	Lab Contents	No. of Hours
1	Identification of Crystal forms	**2**
2	Microscopic studies of important rocks and minerals through thin section slides	**3**
3	Studies of representative aerial photographs under Mirror Stereoscope	**3**
4	Understand Geological maps & their utility in the Civil Engineering Projects	**3**
5	Draw structural & cross sectional profiles from the Geological map.	**3**

Course Outcomes:

At the completion of this course, students will be able to:	
1.	Ascertain rocks and know their occurrence
2.	Distinguish minerals in hand specimen and under the microscope
3.	Use aerial photographs for interpretation of different landforms and to apply knowledge of geological structures in engineering construction.

Bibliography:

S. No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1.	"The Dynamic Earth-An Introduction to Physical Geology", Skinner, B.J. and Porter, S.C. John Wiley and Sons, N.Y.	2000
2.	"A Geology for Engineers", Blyth, F.G.H. and de Freitas, M.H. CRC Press.	1994

Classical Books

S. No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1	"Engineering Geology", Goodman, R.E. John Wiley and Sons, NY	1993

MOOC'S on this course are available at:

1. **https://www.nptelvideos.in/2012/11/engineering-geology.html**
2. **https://www.engineering.unsw.edu.au/study/postgraduate/geotechnicalengineering**

Engineering Mathematics

Engineering Mathematics 1 (EM1)

Course Name	:	**FOURIER TRANSFORMS**
Course Code	:	**EMM 5011**
Credits	:	**01**
L T P	:	**2-1-0**
Segments	:	**1-2**

Total No. of Lectures– 10, Tutorials -5

Course Objectives:

The main Objectives of this course are:

1	To make the students understand the concept of Fourier transform and be able to compute it for standard examples.
2	To make the students able to apply Fourier transforms to solve differential equations and partial differential equations.

Course contents:

S. No	Course Contents	No. of Lectures
1	**Fourier Transforms:** Fourier Integral formulas, Definition and examples, Basic properties, Fourier cosine and sine transforms and examples, Basic properties of Fourier cosine and sine transforms, Multiple Fourier transforms.	05
2	**Fast Fourier Transforms and Short Term Fourier Transforms:** Definition and examples, Basic properties, Applications.	05

Course Outcomes:

At the end of the course, students will be able to:	
1	Solve differential equations by using Fourier transforms
2	Solve partial differential equations by using Fourier transforms
3	Apply FFT and STFT to engineering problems

Bibliography:

S. No.	Name of Book / Authors / Publishers	Year of Publication/ Edition
1	"Integral Transforms and Their Applications", Loknath Debnath, CRC Press, Inc.,	1995.
2	"Integral Transforms and their Applications", Brian Davies, 3rd Edition, Springer-Verlag, New York,Inc,	2001
3	"Fourier Transform and Its Applications", Ronald N. Bracewell, 2nd Edition, McGraw-Hill Inc.,US,	1986

Engineering Mathematics 2 (EM2)

Course Name	:	NUMERICAL METHODS
Course Code	:	EMM 5013
Credits	:	01
L T P	:	2-0-2
Segments	:	3-4

Total No. of Lectures – 10, Practical -10

Course Objectives:

The main Objectives of this course are:

1	To make the students understand the basics of numerical methods.
2	To make the students able to solve problems on system of linear equations and Interpolation by numerical methods.

Course contents:

S. No.	Course Contents	No. of Lectures
1	**Error Analysis:** Definition and sources of errors, Propagation of errors, Floating-point arithmetic and rounding errors.	02
2	**Interpolation:** Interpolation using Finite differences, Numerical Differentiation and Numerical integration, Trapezoidal and Simpson's rules.	04
3	**Numerical Solution of Differential Equations:** Picard's method, Taylor series method, Euler and modified Euler methods, Runge-Kutta methods, Predictor-Corrector method.	04

Lab Work:

S. No.	Lab. Contents	No. of Hours
1.	Solving Interpolation, Numerical Differentiation and Numerical integration problems using Mathematica.	04
2.	Solving Differential equations numerically using Mathematica.	06

Course Outcomes:

By the end of the course, the students will be able to solve the following by numerical methods:
1. Problems on Interpolation   2. Problems on Differentiation, Integration.   3. Solve differential equations.

Bibliography:

S. No.	Name of Book / Authors / Publishers	Year of Publication/ Edition
1	"Introduction to Numerical Analysis",Atkinson K. E., John Wiley.	1989
2	"Applied Numerical Analysis", Gerald C. F. and Wheatley P. O., Pearson	2004
3	"Numerical Methods for Scientific and Engineering Computation", Jain M. K., Iyengar S.R.K. and Jain R. K., New Age International Publisher.	2004
4	"Elements of Numerical Analysis", Gupta R.S., Macmillan India Ltd .	2008

Engineering Mathematics 3 (EM3)

Course Name	:	OPTIMIZATION TECHNIQUES
Course Code	:	EMM 5019
Credits	:	01
L T P	:	2-0-2
Segments	:	5-6

Total No. of Lectures – 10, Practical -10

Course Objectives:

The main Objectives of this course are:

1	To make the students understand the need of Optimization Techniques and develop the ability to form mathematical model of optimization problems.
2	To make the students able to identify and solve linear and non-linear models of optimization problems.

Course contents:

S. No.	Course Contents	No. of Lectures
1	Linear Programming: Formulation, Graphical solution, Simplex method.	04
2	Non Linear Optimization Techniques: Unconstrained problems - Necessary and sufficient conditions for extreme points, Newton's method, Guass- Newton method, Parallel axis method. Constrained problems - Lagrangean method , KKT conditions, Nelder Mead method.	06

Lab Work:

S. No.	Lab. Contents	No. of Hours
1.	Solving linear problems using Mathematica/MATLAB.	04
2.	Solving non-linear problems using Mathematica/MATLAB.	06

Course Outcomes:

1	The students are able to form mathematical model of optimization problems.
2	The students are able to distinguish between linear and nonlinear models.
3	The students are able to solve simple problems using Mathematica/MATLAB

Bibliography:

S. No.	Name of Book / Authors / Publishers	Year of Publication/ Edition
1	"Operations Research" , Ravindran , Phillips , and Solberg , 2nd edition, John Wiley & sons .	2000
2	"Engineering Optimization" , S S Rao , 3nd edition, New Age .	2000
3	"Operations Research", Kantiswarup, Gupta P.K. & Sultan Chand & Sons	2007
4	"Operations Research", Sharma S.D., Kedarnath, Ramnath &Company.	1994
5	"Operations Research", Bronson R, Shaum's Outline Series.	1997

SEMESTER -II

Course Name	:	Design of Experiments & Research Methodology
Course Code	:	DRM 5011
Credits	:	3
L T P	:	2-1-0
Segments	:	1-6

Course Objectives

The main Objectives of this course are:
1	To introduce the fundamentals of Statistical techniques, Sampling techniques, and Data collection and their interpretation.
2	To understand concept of research, need for research, types of research and steps in conducting research.

Total No. of contact hour: 42 (L= 28+T=14)

S.No.	Course Content	No. of Lectures
1	**Design of Experiment** Principles of Experimental design, sampling methods, probability sampling	**3**
2	**Modeling** Introduction to modeling, types of models, development of mathematical models	**4**
3	**Random variables** Random variables and its properties, probability distributions, probabilistic model estimation and its assessment	**6**
4	**Random Variables Data Analysis** Single and multi variables data analysis, estimation of parameters, splinessmoothing, Residual analysis, Analysis of Variances	**5**
4	**Random Variates** Simulation, Monte Carlo Method, Queuing Theory, Markovian process	**3**
5	**Geostatistics** Introduction to Geostatistics, Geostatistical data analysis methods	**3**
6	**Stochastic Processes** Time series analysis, model identification, forecast and uncertainty analysis	**2**
7	**Research Report Writing** Research objectives formulation, literature collection, data analysis methods, report writing and conclusions	**2**

Course Outcomes

At the completion of this course, students will be able to:	
1	Students will be able to make use of various Research methodologies and its applications in the relevant field of engineering.
2	Organize and conduct research (advanced project) in a more appropriate manner

Bibliography		
S.No.	**Name of Book/Authors/Publishers**	**Year of Publication/ Reprint**
1	Probability and Statistics for Engineers and scientists, Walpole, Myers, Myers and Ye, Pearson Education.	7th edition, 2002
2	Statistics in Research, BernandOstle and Richard N.Mensing, Oxford & IBH Pub Co.	3rd edition, 1975
3	Probability and Statistics in Engineering, Hines, Montgomery, Goldsman and Borror, John Wiley & Sons.	4th edition, 2003
4	Experimental design, Theory & application, Federer, Oxford & IBH pub Co.	1955
5	Introduction to probability & statistics for Engineers and scientists, Sheldon M. Ross Elsevier Academic press, California, USA	2014

MOOCs on this course are available at:

1.   http://professional.mit.edu/programs/short-programs/design-and-analysis-experiments
     By Prof. Paul Berger, MIT Professional Education

2.   https://nptel.ac.in/courses/107108011/
          By Prof. Amaresh Chakrabarti, Indian Institute of Science, Bangalore

Program Core

Course Name	:	Advanced Hydrology
Course Code	:	CEM 5035
Credits	:	3
L T P	:	2-0-2
Segments	:	1-6

Total No. of Lectures-28
Total No. of Lab Hours-28

Course Objectives:

The main Objectives of this course are:	
1	To introduce the fundamentals of hydrological models used in solving the water resources problems.
2	To understand practical flow aspects of fluid flow in various hydraulic structures such as open channel, canal falls, hydraulic jump, dams and spillway etc.

Course Content:

S.No.	Course Content	No. of Lectures/Tutorials
1	Introduction, Precipitation, Isohytal method, Area depth duration and intensity duration frequency curves, Design applications, Standard Project Storm	10
2	Water Losses, Measurement and estimation of evaporation and transpiration	5
3	Runoff, Rainfall runoff relationship Hydrograph, Design Flood, Unit Hydrograph, Instantaneous Unit Hydrograph	8
4	Flood Routing, Flood Forecasting, Hydrologic Models.	5

Lab (Hydraulic Engineering)

List of Experiments		No. of Hours
1	Flow through Porous Media	2
2	Seepage Analysis Study by Heleshaw Apparatus	2
3	Design of Practical Profile of Gravity Dam	2
4	Seepage and Stability Analysis of Zone Dam	2
5	Estimation of Storage Capacity of Reservoir	2
6	Design of Spillway Profile	2
7	Selection & Design of Energy Dissipaters	2
8	Application of Software for Solving Free Surface Flow Problems, Hydrologic Analysis and simulation Problems	10
9	Estimation of Design Flood & Regional Flood Frequency Analysis	2
10	Hydrologic and Hydraulic Flood Routing	2

Course Outcomes:

	At the completion of this course, students will be able to:
1	analyze the rain fall data with the help of hydrological models and to estimate the design flood.
2	apply the model results in verifying the analysis and design of structures.

Bibliography:

S.No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1	Applied Hydrology; K.N. Mutreja, Tata – Mc-Graw Hill.	1990
2	Hydrology for Engineers, Linsley, Kohler, Mc-Graw Hill.	1949
3	Handbook of Applied Hydrology, V.T.Chaw	1988
4	Enginneering Hydrology, E.M.Wilson, Macmillan	1990
5	Engineering Hydrology ,K.Subramanya, Tata Mc-Graw Hill	1994

Mooc courses:
https://nptel.ac.in/downloads/105101002/

https://nptel.ac.in/courses/105101002/

Course Name	:	Water Resources, Planning & Management
Course Code	:	CEM 5045
Credits	:	3
L T P	:	3-0-0
Segments	:	1-6

Total No. of Lectures: 42

Course Objectives:

The main Objectives of this course are:	
1	To understand the concept of planning of water resources projects including feasibility studies and to learn the concept of relevant mathematical tools.
2	To understand the concept of project analysis, issues in planning and data needed for planning.

Course Content:

S.No.	Course Content	No. of Lectures/Tutorials
1	**Water Resources Planning** Role of water in national development, assessment of water resources, planning process, Project Planning and long term planning, functional requirements in multipurpose planning.	4
2	**Elements of Water Resources Development** Reservoir planning-dependable yield, Sequence peak algorithm sedimentation in reservoir, reservoir capacity, empirical-area reduction method.	8
3	Planning Process and data Needed for Planning, Project analysis, project optimality conditions and profitability analysis.	6
4	**Water Resources system engineering** Concept of system engineering, optimal policy analysis, linear and dynamic programming, Integrated River Basin Development, Water Resources Planning.	8
5	**Application of system approach in water resources** Application of system engineering in practical problems like hydrology, irrigation and drainage engineering, mathematical models for forecasting and other water resources related problems.	10
6	**Economic and Financial Analysis** Meaning and nature of Projects Economics theory, micro and macroeconomics, cost-benefit analysis, discounting factors and techniques, cost allocation and comparison of alternatives.	6

Course Outcomes:

	At the completion of this course, students will be able to:
1	Make use of concept of planning, optimal design criteria and application of economics in water resources projects.
2	Apply the concepts of linear and dynamic programming in real life problems.

Bibliography

S.No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1	Water Resources Systems Engineering, Hall and Dracup, Mc-Graw Hill.	1970
2	Economics of Water Resources Planning, James – Lee, Mc-Graw Hill	1971
3	Water Resources Engineering, Linsley and Franzini, Mc-Graw Hill.	2013
4	Optimization Theory and Applications, S.S.Rao, Wiliey East. Ltd.	1978

Mooc Course:

https://nptel.ac.in/courses/105108081/

Program Elective

Course Name	:	Fluvial Hydraulics
Course Code	:	CEM 5321
Credits	:	1.5
L T P	:	3-0-0
Segment	:	1-3

Total No. of Lectures: 21

Course Objectives

The main Objectives of this course are:	
1	To understand the concept of flow characteristics in an alluvial channel with erodible boundary.
2	To understand the concept of bed and suspended load transport, and interactions with the engineering constructions along a stream.

Course Content:

S.No.	Course Content	No. of Lectures
1	The sediment problems, properties of sediments, incipient motion of uniform and non-uniform sediments.	4
2	Bed forms and channel resistance.	2
3	Bed load and suspended load transport for uniform and non-uniform bed material, total load equations, sediment sampling.	5
4	Stable channel design and sediment control.	2
5	Bed level variations, local scour, degradation, aggradations and reservoir sedimentation.	4
6	Physical and mathematical models.	2
7	Design of guide bunds and other river training banks	2

Course Outcomes:

At the completion of this course, students will be able to:	
1	Design the mobile boundary channel, river training works.
2	Solve simple hydraulic problems by numerical or graphical methods.

Bibliography:

S.No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1	"River Morphology", Garde, R.J., New International Publishers.	2006
2	"Erosion and Sedimentation", Julien, P.Y., Cambridge University Press.	1998
3	"Principals of River Engineering", Jansen, P.P.H., VSSD Publications.	1994

4	"Mechanics of Sediment Transportation and Alluvial Stream Problems", Garde, R.J. and Ranga Raju, K.G., Wiley Eastern Limited.	2006

Mooc Courses:
https://nptel.ac.in/courses/105105110/pdf/m2l10.pdf

Course Name	:	Design of Hydraulic Structure
Course Code	:	CEM 5322
Credits	:	1.5
L T P	:	3-0-0
Segments	:	1-3

Total No. of Lectures: 21

Course Objectives:

The main Objectives of this course are:	
1	To know the basics of Hydraulic structures along with the design of different components associated with it.
2	To get knowledge of various types of dam and understand different elements of dam.

Course Content:

S.No.	Course Content	No. of Lectures
1	Planning and investigations of reservoir and dam sites, Choice of dams, preparation and protection of foundation and abutments.	**2**
2	Forces acting on solid gravity dam, modes of failures, stability analysis, elementary and practical profile of gravity dam, internal stresses and stress concentrations in gravity dam joints, seals, keys in gravity dams, dam safety and hazard mitigation ,IOT in Dams and Reservoir operation	**4**
3	Homogeneous and zoned embankment dams, factors influencing design of embankment dams, criteria for safe design of embankment dam, steps in design of embankment dam, seepage analysis and its control through body and dam foundation, classification of rock fill dams and their design considerations**,** Instrumentation in Earthen Embankment	**4**
4	Capacity of spillways, components and profile of different types spillways, Non-conventional type of spillways, selection and design of energy dissipaters	**4**
5	Components of diversion head works and their functions, design of weirs and barrages on permeable foundations	**3**
6	Canal regulation structures and design of cross drainage works, canal drops, operation and maintenance of canals.	**3**
7	Review of codes of practice	**1**

Course Outcomes:

	At the completion of this course, students will be able to:
1	Design the various hydraulic structures on the basic of designed flood flow and their proper regulations.
2	Integrate relevant concept and methodologies in the area of hydraulics, hydrology and geotechnical engineering.

Bibliography:

S.No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1	USBR, "Design of gravity dams", A Water Resources Technical Publication, Denver, Colorado	1976
2	USBR, "Design of small dams", A water resources technical publication, Oxford and IBH publishing co., New Delhi	1974
3	Creager W P, Justin J D and Hinds J., "Engineering for dams" Nemchand and Brothers, Roorkee	1995
4	Khatsuria R M, "Hydraulics of spillways and energy dissipators", CRC Press	2005
5	Novak P, "Hydraulic Structures", Taylor and Francis Group publishers	2001

Mooc Courses:

https://nptel.ac.in/courses/105105040/

Course Name	:	**Advanced Foundation Engineering**
Course Code	:	**CEM 5323**
Credits	:	**1.5**
L T P	:	**3-0-0**
Segments	:	**1-3**

Total No. of Lectures: 21

Course Objectives:

The main objectives of the course are:	
1.	To learn the different types of foundation and their suitability for particular site and structure.
2.	To understand soil-structure interaction and calculation of allowable load and settlement of the foundation

Course Contents:

S. No.	**Course Contents:**	No. of Lectures
1.	**Shallow Foundations**: Design considerations- factors of safety (including limit state), allowable settlements, location and depth of foundations, Codal provisions, Consolidation settlement in clays (with correction factors). Immediate settlement. Settlement in sands from N-values, elastic solutions. Static cone tests, Plate load tests.	**6**
2.	**Deep foundations:** Type of Piles. Construction methods. Axial capacity of single piles-static formulae, Skin friction and end bearing in sands and clays. Axial capacity of groups, Codal provisions. Laterally Loaded Piles: Short and long piles; Free head and fixed head piles; Lateral load capacity of single piles; Lateral deflection; Elastic analysis; Group effect; Lateral load test; Codal provisions. Caissons and Wells.	**5**
3.	**Soil structure interaction:** Introduction to soil-foundation interaction problems, soil behaviour , Foundation behaviour, Interface behaviour, Soil Foundation interaction analysis, Soil response models, Winkler, Elastic continuum, Two parameter elastic models, Elastic plastic behaviour, Time dependent behaviour.	**4**
4.	Soil Liquefaction and remedial measures, stone column, vibrfloatation, deep compaction.	**3**
5.	**Foundations in difficult soils:** Expansive soils, chemically aggressive environment, soft soils, fills, regions of subsidence.	**3**

Course Outcomes:

	At the completion of the course, students will be able to:
1.	Decide the type of foundation required for a particular site and structure.
2.	Make geotechnical design of the foundations for civil engineering structures under varied field conditions.

Bibliography:

S. No.	Name of Book/Authors/Publisher	Year of Publication/ Reprint
1.	Foundation Analysis and Design, Joseph E. Bowles, Mc-Graw Hill Publications	1997
2.	Design aids in soil mechanics and foundation engineering, Kaniraj S.K., Mc-Graw Hill Publications	1988
3.	Pile Foundation Analysis and Design, Poulos H.G. and Davis, E.H., John Wiley,1980.	1980

MOOCs on this course are available at:

1. https://nptel.ac.in/courses/105105039/
    By Prof.Kousik Deb,Indian Institute of Technology, Kharagpur

2. https://freevideolectures.com/course/2674/foundation-engineering
    By Prof.N.K.Samadhiya,Indian Institute of Technology, Roorkee

3. https://www.surrey.ac.uk/postgraduate/advanced-geotechnical-engineering-msc-2018
    By Prof.S.Bhattacharya,University of Surrey, England

Course Name	:	Watershed Management
Course Code	:	CEM 5423
Credits	:	1.5
L T P	:	3-0-0
Segments	:	4-6

Total No. of Lectures: 21

Course Objectives:

The main Objectives of this course are:	
1	To study the concept of watershed management through rain water harvesting and recharge technique.
2	To understand land use classification and impact of land use changes on hydrological cycle parameters

Course Content:

S.No.	Course Content	No. of Lectures/Tutorials
1	Hydrology of small watersheds, Concept of sustainable development	3
2	Concept of watershed, Land preparation, conservation measures	3
3	Reclamation of saline soils, utilization and salvaging of water	3
4	Water harvesting and recharge	3
5	Conjunctive use and integrated water resource management, Artificial recharge	4
6	Biomass management, Micro farming	2
7	Integrated approach, Sustainable economic viability	3

Course Outcomes:

At the completion of this course, students will be able to:	
1	Design the rain water harvesting structure in a particular watershed.
2	Assess the current status of the watershed at field, by taking up accurate investigation measures and conduct survey

Bibliography:

S.No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1	Water Resources Conservation and Management, Chatterjee, S. N., Atlantic Publishers	2008
2	Land and Water Management, Murthy, V.V.N., Khalyani Publishers	2004
3	Watershed Management, Muthy, J. V. S., New Age International Publishers	1998
4	Soil and Water Conservation Practices, Suresh Rao, Standard	1998

	Publishers		

Mooc Courses:https://nptel.ac.in/courses/105101010/

Course Name	:	Groundwater Engineering
Course Code	:	CEM 5421
Credits	:	1.5
L T P	:	3-0-0
Segments	:	4-6

Total No. of Lectures: 21

Course Objectives:

The main Objectives of this course are:	
1	To introduce the basic concept of Ground water Engineering and to learn the analytical technique in ground water flow analysis.
2	To understand governing equations of groundwater flow and implement in groundwater modeling.

Course Content:

S.No.	Course Content	No. of Lectures/Tutorials
1	Role of Ground Water in Hydrologic cycle	2
2	Classification of Aquifers, Flow and Storage, Characteristics of Aquifers	2
3	Darcy's Law, Governing Equations of Ground Water, Ground Water-Inventory	4
4	Flow – into wells, Construction of wells, Shallow wells	4
5	Replenishment of Ground water, Investigations of ground water	4
6	Ground water Management, Salinity problems in aquifers, Ground Water modeling	5

Course Outcomes:

At the completion of this course, students will be able to:	
1	Solve ground water real life problems.
2	Estimate the ground water potential in the region under consideration.

Bibliography:

S.No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1	Johnsons – Groundwater and wells – Johnson and Johnson Publication.	1986
2	Todd. D.K. Groundwater Hydrology – Wiley.	2007
3	H.M.Raghunath, Ground Water – Wiley Eastern Ltd	2007

Mooc Courses:
https://nptel.ac.in/courses/105103026

Course Name	:	Bridge Engineering
Course Code	:	CEM 5422
Credits	:	1.5
L T P	:	3-0-0
Segments	:	4-6

Total No. of Lectures: 21

Course Objectives:

The main objectives of the course are:	
1.	To familiarize with the types, suitability, selection, design criteria of various types of bridges.
2	To impart knowledge for analysis and design of various types of bridges.

Course Contents:

S.No.	Course Contents:	No. of Lectures
1.	**General Bridge Systems:** Considerations in alignment, Planning, Economic considerations, Aesthetics and selection of type of bridge, Geometrical Proportion, Bridge Hydrology, Scour Depth, Depth of foundation, Estimation of Design Discharge	3
2.	**Loading Standards:** Specifications for loading, Rail-cum-Road bridges, Indian Road Congress and Indian Railway loading standards.	3
3.	**Design of Bridges:** Reinforced Concrete Bridges, Slab culverts, T-Beam Bridges, Introduction to Box Girder Bridges.	6
4.	**Bridge Bearings:** Design of Elastomeric Bearings	2
5.	**Design of sub structure –** Introduction to design of Piers and Abutments.	4
6.	**Limit State concept for Design of RCC bridges–** Introduction to limit state design of RCC Bridges as per IS Standards	3

Course Outcomes:

At the completion of the course, students will be able to:	
1.	Plan and design the superstructure of RCC bridges.
2.	design the substructure and bearing of the bridge.

Bibliography:

S.No.	Name of Book/Authors/Publisher	Year of Publication/ Reprint
1.	Design of Bridges, N.KrishnaRaju , Oxford and IBH Publications	2006
2.	Essential of Bridge Engineering, Victor D.J, Oxford & I.B.H.	2014
3.	Bridge Superstructure, N. Rajagopalan, Narosa Publishing House	2006
4.	Bridge Engineering Handbook, W. F. Chen and L. Duan, CRC press	2003
5.	Bridge Deck Analysis, E. J. O'Brien, and D. L. Keogh, Taylor and Francis	1999
6.	Structural Bearings, H. Eggert and W. Kauschke, Ernst &Sohn	2002

Classical Books:

S.No.	Name of Book/Authors/Publisher	Year of Publication/ Reprint
1.	Design of Prestressed Concrete Structures, T. Y. Lin and N. H. Burns, John Wiley and Sons	1981
2.	Bridge Analysis Simplified, B. Bakht and L.G. Jaeger, McGraw Hill	1987
3.	Dynamics of Railway Bridges, L. Fryba, Thomas Telford	1996

MOOCs on this course are available at:

1.　http://enggprog.com/archives/2011/12/25/lectures-on-introduction-to-bridge-engineering
　　By Dr. Shahzad Rahmad,University of Engineering and Technology, Peshawar

2.　https://onlinecourses.nptel.ac.in/noc17_ce24/preview
　　By Prof.Nirjhar Dhang,Indian Institute of Technology, Kharagpur

Course Name	:	Embankment Dams
Course Code	:	CEM 5424
Credits	:	1.5
L T P	:	3-0-0
Segments	:	4-6

Total No. of Lectures: 21

Course Objectives:

The main Objectives of this course are:	
1	To introduce types and design of embankment dams and their analysis along with construction aspects.
2	The student will have knowledge of establishing design (or loading) conditions to which the slope may be subjected during its life and performing analyses of stability for each of these conditions.

Course Content:

S.No	Course Content	No. of Lectures/Tutorials
1	Introduction, advantages of embankment dams, types of embankment dams, safety criteria for design of embankment dams, factors affecting the design of embankment dams.	4
2	Theoretical analysis of seepage through embankment and its applications, control of seepage through embankment and foundation.	6
3	Stability analysis including seismic considerations.	6
4	Rockfill dams.	1
5	Methods of construction for embankment and salient aspects of construction including construction equipments, instrumentation, and field and laboratory tests for quality control, typical problems associated with embankment dams and their possible solutions	4

Course Outcomes:

At the completion of this course, students will be able to:	
1	Design the embankment dam and their stability analysis.
2	have knowledge of determining method of analysis (computer program, charts, and hand calculations) according to the complexity of the site or job and the data available to define the site conditions.

Bibliography:

S.No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1	"Earth and Earth-Rock Dams", Sherard, J.L. et. Al., John Wiley.	1963
2	"Engineering for Embankment Dams", Singh, B., and Varshaney, R.S., OIBH.	1995
3	"Design of Small Dams", USBR Publications, OIBH.	1960,1973
4	"Hand Book of Dam Engineering", Golze, A.R., OIBH.	1977
5	"Embankment Dams", Sharma, H.D., India Book House Ltd.	1991
6	"Earth and Rockfill Dams", Singh, B., and Sharma, H.D., Nem Chand and Brothers.	1976
7	"Seepage, Drainage and Flownets", Cedergren, H.R., John Wiley.	1997
8	"Construction, Planning, Equipment and Methods", Peurifoy, R.L., McGrawHill.	2010

Mooc Courses:

https://nptel.ac.in/courses/105105110/pdf/m4l04.pdf

Open Elective

Course Name	:	Design of Hydraulic Structure
Course Code	:	CEO 5005
Credits	:	1.5
L T P	:	3-0-0
Segments	:	1-3

<div align="right">**Total No. of Lectures: 21**</div>

Course Objectives:

The main Objectives of this course are:
1	To know the basics of Hydraulic structures along with the design of different components associated with it.
2	To get knowledge of various types of dam and understand different elements of dam.

Course Content:

S.No.	Course Content	No. of Lectures
1	Planning and investigations of reservoir and dam sites, Choice of dams, preparation and protection of foundation and abutments.	**2**
2	Forces acting on solid gravity dam, modes of failures, stability analysis, elementary and practical profile of gravity dam, internal stresses and stress concentrations in gravity dam joints, seals, keys in gravity dams, dam safety and hazard mitigation , **IOT in Dams and Reservoir operation**	**4**
3	Homogeneous and zoned embankment dams, factors influencing design of embankment dams, criteria for safe design of embankment dam, steps in design of embankment dam, seepage analysis and its control through body and dam foundation, classification of rock fill dams and their design considerations**. Instrumentation in Earthen Embankment**	**4**
4	Capacity of spillways, components and profile of different types spillways, Non-conventional type of spillways, selection and design of energy dissipaters	**4**
5	Components of diversion head works and their functions, design of weirs and barrages on permeable foundations	**3**
6	Canal regulation structures and design of cross drainage works, canal drops, operation and maintenance of canals.	**3**
7	Review of codes of practice	**1**

Course Outcomes:

	At the completion of this course, students will be able to:
1	Design the various hydraulic structures on the basic of designed flood flow and their proper regulations.
2	Integrate relevant concept and methodologies in the area of hydraulics, hydrology and geotechnical engineering.

Bibliography:

S.No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1	USBR, "Design of gravity dams", A Water Resources Technical Publication, Denver, Colorado	1976
2	USBR, "Design of small dams", A water resources technical publication, Oxford and IBH publishing co., New Delhi	1974
3	Creager W P, Justin J D and Hinds J., "Engineering for dams" Nemchand and Brothers, Roorkee	1995
4	Khatsuria R M, "Hydraulics of spillways and energy dissipators", CRC Press	2005
5	Novak P, "Hydraulic Structures", Taylor and Francis Group publishers	2001

Mooc Courses:

https://nptel.ac.in/courses/105105040/

Course Name	:	Groundwater Engineering
Course Code	:	CEO 5006
Credits	:	1.5
L T P	:	3- 0 -0
Segments	:	4-6

Total No. of Lectures: 21

Course Objectives:

The main Objectives of this course are:	
1	To introduce the basic concept of Ground water Engineering and to learn the analytical technique in ground water flow analysis.
2	To understand governing equations of groundwater flow and implement in groundwater modeling.

Course Content:

S.No.	Course Content	No. of Lectures/Tutorials
1	Role of Ground Water in Hydrologic cycle	**2**
2	Classification of Aquifers, Flow and Storage, Characteristics of Aquifers	**2**
3	Darcy's Law, Governing Equations of Ground Water, Ground Water-Inventory	**4**
4	Flow – into wells, Construction of wells, Shallow wells	**4**
5	Replenishment of Ground water, Investigations of ground water	**4**
6	Ground water Management, Salinity problems in aquifers, Ground Water modeling	**5**

Course Outcomes:

At the completion of this course, students will be able to:	
1	Solve ground water real life problems.
2	Estimate the ground water potential in the region under consideration.

Bibliography:

S.No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1	Johnsons – Groundwater and wells – Johnson and Johnson Publication.	1986
2	Todd. D.K. Groundwater Hydrology – Wiley.	2007
3	H.M.Raghunath, Ground Water – Wiley Eastern Ltd	2007

Mooc Courses:
https://nptel.ac.in/courses/105103026