Department of Mining Engineering, VNIT, Nagpur

Scheme of Examination for M.Tech.(Excavation Engg)

(Approved by BOS Mining Engg. and Senate)

(From July 2015)

Four Semester Course : Two Years

1. Objectives:

- Establishment of a national level post graduate education center in the area of Excavation Engineering with mining and civil applications.

- To train students at post graduate level in the area of rock excavation engineering and produce professionals to serve the challenges of the huge rock excavation industry in the country.

-To generate new knowledge and enhance economy, productivity and safety of excavation industry including mining, tunneling, building materials production, and underground space technology.

2. Need :

Excavation industry has seen an exponential growth in India in the last decade with respect to rock excavations for slopes, tunnels, surface mines, underground mines, underground caverns for power houses, storage for army, foundations for high rise building, railways, Metros etc. Some of the challenging problems facing the industry are in the areas of deep excavations, excavations in fragile and mountainous regions, excavations and tunneling in urban areas, utilization of underground space in urban areas for storage, waste disposal and habitats, reduction in excavation costs, management of excavations, and making mining ores and building material profitable and sustainable. Professionals trained in the above areas are essentially to meet the challenges and contribute effectively in this nation building activity. This course is intended to provide the input to mining and civil engineers to enhance their engineering knowledge in the field of excavation engineering which would be useful to serve the construction and mining industry in most technically effective way.

3. Eligibility : The students having UG degrees BE/B.Tech or equivalent with first class in Mining or Civil Engg will be eligible to seek an admission to this course and as per **CCMT guidelines**. GATE qualified/ Institute Test in case of vacancy.

4. Intake : As per institution norms. : For 2013

Course /Category	GEN	OBC	SC	ST	OBPWD*	Total
M.Tech. (Excavation Engg)	10	04	03	02	1	20

GEN- General , OBC-Other Backward Classes, SC-Scheduled Caste, ST-Scheduled Tribe,
PWD- Persons With Disabilities,
Reservation as per Government of India Rules.
* PWD seats will be merged to respective category if the candidates are not available.

Department of Mining Engineering, VNIT, Nagpur
M.Tech(Excavation Engg): Four Semester Course : Two Years

Scheme and Credits

Post graduate Core (PC)		**Postgraduate Elective (PE)**	
Category/Courses	**Credit**	**Category**	**Credit**
PG Core(DC)	34	PG Electives(DE)	12
Engineering Arts and Sciences (BS)	3	Open Courses(OC)	0-3
Sub Total	**37**	**Sub Total**	**15**
Grand Total PC + PE			**52**

(Semester-wise Mapping)

I Semester				**II Semester**			
PG CORE				**PG CORE**			
Code	Course	L-T-P	Credits	Code	Course	L-T-P	Credits
	Engineering Arts and Sciences (BS)						
MAL 521	Advanced Mathematics	3-0-0	3	MNL 525	Blasting Technology in Excavations	3-0-0	3
	Departmental Core (DC)			MNP 525	Blasting Technology in Excavations - Pract	0-0-2	1
MNL 522	Geo-mechanics in Excavations	3-0-0	3	MNL 526	Tunnel and Cavern Engineering	3-0-0	3
MNP 522	Geo-mechanics in Excavations - Pract	0-0-2	1	MNL 527	Geo-Environmental Engineering	3-0-0	3
MNL 523	Underground Excavation Equipment	3-0-0	3	MNP 527	Geo-Environmental Engineering- Pract	0-0-2	1
MNL 524	Surface Excavation Technology and Equipment	3-0-0	3	MND525	Field visit and demonstrations		1
PG Electives (Any One)				**PG Electives (Any Two)**			
MNL 532	Advanced Engineering Geology	3-0-0	3	MNL 528	Modeling Techniques and Computer Applications	3-0-0	3
MNP 532	Advanced Engineering Geology	0-0-2	1	MNP 528	Modeling Techniques and Computer Applications - Pract	0-0-2	1
MNL 529	Contract and Construction Management	3-1-0	4	MNL 531	Slope Engineering	3-1-0	4
	Open Courses			MNL 530	Ground Improvement Engineering	3-1-0	4
					Open Courses		
	Total		17		Total		20

III Semester				VI Semester			
PG CORE				**PG CORE**			
Code	Course	L-T-P	Credits	Code	Course	L-T-P	Credits
	Departmental Core (DC)			MND 541	Dissertation –Seminar-Viva-voce: Phase-II		9
MND 540	Dissertation- Seminar :Phase -I		3				
PG Electives (Any One)							
MNL 533	Instrumentation in excavation	3-0-0	3				
MNL 534	Grouting Technology	3-0-0	3				
	Total		6		Total		9

		L -T- P
MAL 501	**Advanced Mathematics**	3-0-0

Course Objectives:

- To provide advanced knowledge of applied mathematics
- To improve analytical capability of students

Content:

Linear Algebra & Matrices: Linear Vector Spaces, Linear dependence, basis and dimensions, Four fundamental subspaces, Linear transformations, Transformation from one linear space to another, Inner product space and applications, Eigen values and Eigen vectors, diagonalization, complex matrices, similarity transformations, matrix norms & condition number, iterative methods for solving AX = b.

Numerical Techniques: Review of the topics in elementary numerical analysis,

Basic Principles, Construction of approximate integration formulae using method of undetermined weights & nodes, Gauss- Legendre formula, Gauss Chebyshiv

formula, Gauss-Hermite formula, Errors in numerical integration.

Finite Difference Methods : Approximation of derivatives (Ordinary & Partial) in terms of pivotal values: Application to solve

1. Boundary value problems in ordinary differential equations
2. Boundary value problems in partial differential equations: Laplace equation, one dimensional heat equation and one dimensional wave equation.

Introduction to Mathematical Modeling: Study of cases of modeling through

linear equations and differential equations.

Books:

1. Advanced Engineering Mathematics, R.K. Jain, S.R.K. Iyengar, Narosa
2. Linear Algebra and its Applications , Gilbert Strang, Thomson India Edition 5th
3. Applied Mathematics, Francis B. Hilderbrand ,Prentice Hall of India
4. Numerical methods for scientific and engineering Computations ,Jain, M.K. , Iyengar S.R.K., and Jain, R.K., New Age Publications

		L -T- P
MNL 502	**Geo-mechanics in Excavations**	**3-0-2**

Course Objectives:

- To provide advanced knowledge of geo-technical aspects of excavation engg.
- To make student aware about the design consideration with regards to geo-mechanics

Content:

Soil mechanics:Advanced soil properties Mechanical behaviour of soil, Analysis and constitutive models Basic dynamics and analysis of strong motion data, Earth pressures, Earthquake geotechnical engineering, Embankments and earthworks, Engineering seismology Foundations, Ground profiles and ground investigation, Strength and deformation

Geological structures in rockmass, Objective and methods of rockmass characterization Rock Mass Classification, Methods of determination of strength and deformability of rock and rockmass

Failure criteria for rock and rockmass, Mechanics of rock fracture, Failure mechanism of excavation in rock, Influence of anisotropy and discontinuity on rock behaviour

Pre-mining state of stress: sources, methods of determination and presentation, Stress distributions around single and multiple openings in rocks: methods estimation factors, Propagation of elastic waves in rock medium and dynamic behaviour of rocks influencing stress concentration; zone of influence of an excavation: effect of planes of weaknesses and shape of excavations; delineation of zone of failure

Investigation of Rock Condition, Selection of opening shape and size, geological and geophysical investigations, 3D geological logs, preparation of Stereo-nets

Introduction to mechanics of rock cutting, drilling

Books:

1. Karl Terzaghi, Ralph B. Peck, Gholamreza Mesri Soil Mechanics in Engineering Practice
2. HUDSON, J.A., Rock mechanics series
   William A. Hustrulid, Michael K. McCarter, Dirk J.A. Van Zyl,
   Slope Stability in Surface Mining Society for Mining, Metallurgy, and Exploration, Inc
3. HUDSON, J.A. & HARRISON, J.P. (1997). Engineering Rock Mechanics: an Introduction to the Principles. Elsevier.
4. Brady, B. H. G. & Brown, E. T. (1993):Rock Mechanics For Underground Mining, 2nd Edition, Chapman & Hall
5. Goodman, R. E. (1989):Introduction to Rock Mechanics, 2nd Edition, New York: John Wiley & Sons.
6. Hoek, E and Bray, J (1981):Rock Slope Engineering, 3rd Edition, The Institution of Mining and Metallurgy, London

		L -T- P
MNL 503	**Underground Excavation Equipment**	**3-0-0**

Course Objectives:

- To give detail idea about the equipment used in underground excavation.
- To make student aware about the latest techniques

Content:

Introduction to various types of drilling equipment for underground excavations;

Roadheading machines - road headers, dintheaders, and Tunnel Boring Machines; their selection, construction &. operation for underground excavation

Shaft drills and mucking system; shaft boring machines, raise boring machines,

Introduction to loading and transportation techniques; different types of loading machines, LHDs SDLs, LPDTs, CAVO loader, rocker shovel loader, gathering arm loader

Introduction to automation, robotics and radio control operations in excavation equipment, Fore-poling machines, Shotcrete machines, grouting pump

House Keeping of equipment, performance optimization, Cost and downtime management, optimization of equipment utilization, workshop equipment management**.**

Books:

1. H.L.Hartman SME, Mining Engineering Hand Book, Society of Mining Engg, USA
2. Hustrulid, Underground mining methods, SME

		L -T- P
MNL 504	**Surface Excavation Technology and Equipment**	**3-0-0**

Course Objectives:

- To give detail idea about the equipment used in surface excavation including their construction, selection, limitations and capacity calculation
- To make student aware about the modern techniques and Introduction of various maintenance systems

Content:

Introduction to surface excavating methodologies and equipment

Classification of surface excavating equipment systems vis-a-vis unit operations,

Equipment selection criteria and procedures; application and selection guidelines for different types of equipment

Dozers. rippers, blasthole drills, shovels, draglines, scrapers, bucket wheel excavators, continuous surface miners, continuous face miners: construction, application and capacity

Front-end loaders, dumpers, conveyors and ropeways: construction, application and capacity

Basic_operations. Maintenance, scheduling and capacity utilization, applicability and selection considerations

Books:

1. Howard L. Hartman. SME, Mining Engineering Hand Book, Society of Mining Engg, USA
2. Hustrulid, Underground mining methods, SME publications
3. Hustrulid, Open cast mining

		L -T- P
MNL 505	**Blasting Technology in Excavations**	**3-0-2**

Course Objectives:

- To provide advance knowledge of blasting
- To develop designing capability for blasting in excavation

Content:

Chemistry and physics of explosives; properties of explosives

Explosives and blasting agents; initiation and priming systems bulk explosives; explosive selection

Rock breakage by explosives theories, laws of comminution, methods for prediction and assessment of fragmentation;

Design of blasting rounds for surface and underground excavation, special blasting techniques-including secondary breakage, pre-splitting, destress blast technique, Lake tap design

Profiling, trenching, casting and demolition, environments considerations, handling and storage of explosives control of noise, vibration, air blast and fly rock

Blasting optimization, intelligent blast design, blast economics, computer applications in blasting

Books:

1. Dr. Calvin Konya, Rock Blasting and Overbreak Control

2. Stig o Olofsson, Applied explosive technology for construction and mining, APPLEX P O Box 71 S-640 43 ÄRLA SWEDEN

		L -T- P
MNL 506	**Tunnel and Cavern Engineering**	**3-0-0**

Course Objectives:

- To make students aware of tunneling technology and its latest development
- To develop tunnel and cavern design capability

Content:

Types of underground excavations: tunnel, shaft, cavern, etc

Parameters influencing location of a tunnel and its design, planning and site -investigation for tunneling, methods of tunneling; selection of method of excavation

Tunneling in soft ground, Tunneling in rock by road heading machines: cutting principles, method of excavation, performance limitations and problems

Tunneling in rock by tunnel boring machines: method of excavation, performance, limitations and problems, TBM application in coal mines, TBM for soft formations, micro- tunneling

Excavation of large tunnels, special storage and underground space, caverns for hydro-electric projects No-Dig technology, NATM & NTM methods, short life excavations, tunneling under water bodies

Cut and cover tunnels, metro tunnels Hazards in tunneling.
Supports in tunnels Tunnel services: ventilation, drainage and lighting and maintenance

Books:

1. Bickel, J.O., Kuesel, T.R., and King, E.H., 1996, Tunnel Engineering Handbook (Second Edition), Chapman & Hall, 544 pages.
2. Bieniawski, Z..T., 1992, Design Methodology in Rock Engineering, A.A. Balkema, 196 pages. rtman : SME Mining Engineering Handbook
3. Whittaker, B. N. and Frith, R. C. (1990): Tunneling: Design, Stability and Construction, London: Institution of Mining and Metallurgy
4. Hoek, E and Brown, E.T. (1980):Underground Excavation in Rock, The Institution of Mining and Metallurgy, London
5. Mahtab, M.A., and Grasso, P., 1992, Geomechanics Principles in the Design of Tunnels and Caverns in Rocks, Elsevier Press, 250 pages.
6. Bieniawski, Z. T. (1984):Rock Mechanics Design in Mining and Tunneling, Balkema

		L -T- P
MNL 507	**Geo-Environmental Engineering**	**3-0-2**

Course Objectives:

- To make students aware environmental concerns of excavation
- To develop skill of environmental documentation

Content:

Environment management in excavation, design of ventilation, lighting, emergency management.

Land, water and air pollution issues due to excavations Contaminated Land, Ground Contamination due to excavations The Land Environment, Land Environment Sensitivity and Tolerance Land Suitability and Use Wastes and Waste Streams

Nature of Soils: Soil Materials in the Land Environment, Soil Materials Physical Properties, Soil-Water Systems

Pollutants of Major Concern, Gas Detection, Water contamination or loss due to excavation Dust, SPM

Disposal of debris and its management

EIA, ERA, EMP, emergency & disaster management in excavations.

Books:

1. Lakshmi N. R., Hilary I. I., (2000):Geoenvironmental Engineering: Principles and Applications, Marcel Dekker
2. Car, Y. B. and Daniel, D. E., (1995):Geoenvironment 2000 - Characterization, Containment, Remediation, and Performance in Environmental Geotechnics, Geotechnical Special Publication No. 46, ASCE Press, New York, USA.
3. Bear, J. and Verruijt, A. (1990):Modeling Groundwater Flow and Pollution, Reidel P.C., Dordrecht, The Netherlands.
4. Bedient, P. B., Rifai, H. S. and Newell, C. H. (1994):Ground water contamination- Transport and Remediation, PTR Prentice Hall, NJ, USA.
5. Daniel, D. E., (1993):Geotechnical Practice for Waste Disposal, Chapman & Hall, London.

		L -T- P
MNL 508	**Modeling Techniques and Computer Applications**	**3-0-2**

Course Objectives:

- To make students aware of modeling techniques
- To provide training in computer modeling

Content:

Introduction to modeling, physical. Mathematical , computer modeling

Mathematical modeling, methods with different techniques,

Excavation modeling with DTM and block models

Introduction to use of Finite Element method, boundary element method in modeling, finite difference method

Simulation, Virtual reality in excavation, study of excavation design software

Application of software in design, planning and scheduling of excavations
Preparation of computer models using available software for excavations

Books:

1. Rachez, C. Detournay, and R. Hart (*Editors*). FLAC and numerical modeling in geomechanics 2001 Proceedings of the Second International FLAC Symposium, Lyon, France, 29–31 October 2001. D. Billaux, X. A.A. Balkema, Rotterdam,

2. Whittaker, B. N. and Frith, R. C. (1990): Tunneling: Design, Stability and Construction, London: Institution of Mining and Metallurgy

3. Hoek, E and Brown, E.T. (1980):Underground Excavation in Rock, The Institution of Mining and Metallurgy, London

4. Bieniawski, Z. T. (1984):Rock Mechanics Design in Mining and Tunneling, Balkema

		L -T- P
MNL 509	**Contract and Construction Management**	**3-0-0**

Course Objectives:

- To provide knowledge about legal aspects of contract
- To develop skill regarding contract documentation and management

Content:

Introduction to preparation of contract, clauses, Drafting of contracts

Legal provisions of contract, Negotiations, bids preparation

Case of excavation and construction contract, Use of software for contract and construction management

Project management, schedule preparation, Time management in work execution
Construction management practice

Use of software for contract and construction management, work scheduling, resource allocation

Relevant Codes for excavations, permissions from various government and other agencies, Finance and economics, Financial risk managements, project scheduling, costing.

Books:

1. Dave Roberts, Pipe and Excavation Contracting, Published by:
   Craftsman Book Company P.O. Box 6500, Carlsbad, CA 92018, www.craftsmanbook.com/cbcstore/
2. Excavating and Grading Handbook

		L -T- P
MNL 510	**Ground Improvement Engineering**	**3-0-0**

Course Objective:

- To provide knowledge of ground reinforcement and improvement techniques of surface and underground excavation

Content:

Basics, purpose, principles. Ground improvement techniques for excavation, types and application

Support classification for surface and subsurface excavations, Rock bolts, cable bolts, side stitching, rock binding

Geo-synthetics: geo-textile application, soil improvement technologies, Ground retaining techniques, diaphragm walls, soil stabilization: stone columns, sand piles, dynamic compaction, binding,. Piling

Methods of Grouting, Jet grouting**,** shotcretting, guniting

Supports in tunnels and caverns, linings, design

Design of slope in various rock conditions, Slope stability, slope failure analysis

Dump design and management

Books:

1. M.P.Moseley, Ground improvement, Blackie Academic& Professionals, CRC, Press Inc., USA, Canada
2. C. Houlsby; Construction and Design of Cement Grouting : A Guide to Grouting in Rock Foundations(April 1990) John Wiley & Sons (Sd); ISBN: 0471516295

	L -T- P
MNL 511 Slope Engineering	**3-0-0**

Course Objective:

- Introducing natural slopes, man-made slopes, overburden dumps and damage it has caused due to destabilization, all over the World in the past and factors responsible for causing destabilization in case of these slopes.
- Data collection, analysis of slopes using older analytical techniques and modern techniques like numerical modeling.
- Detail study of various slope stabilization techniques and Monitoring of slopes

Content:

Introduction to the basic mechanics of slope failure. Slope failure mechanisms and their analysis. Modes of rock slope failure Slope formation techniques.

Geologic data collection, Defect, discontinuities, Engineering properties of discontinuities, rock mass shear strength, Stress, strain and strength, Drained and undrained strength parameters, Laboratory and field tests for shear strength, Hemispherical projection techniques, stereo-nets

Elements of slope and design parameters. Pit slope design, Infinite slope Block analysis Method of slices Design charts Seismic analysis Effective and total stress analysis Groundwater effects, Water forces on soil, Flow through porous media, Hydraulic conductivity, Flow nets, Determination of water pressure, seepage forces and quantity of seepage

Land slides, causes and processes, Post failure analysis of slopes, data collection and interpretation

Slope stability: Stabilization techniques, Earth retaining structures, Reinforced embankments, Embankments on soft ground, Instrumentation and Slope monitoring techniques and interpretation, Slope stability problems in waste disposal, Construction excavations

Numerical modeling for slope design, Limiting equilibrium method, design of slope using computer software, Computer program for slope stability analysis

Books:

1. Hoek, E and Bray, J (1981):Rock Slope Engineering, 3rd Edition, The Institution of Mining and Metallurgy, London
2. HUDSON, J.A., Rock mechanics series
   William A. Hustrulid, Michael K. McCarter, Dirk J.A. Van Zyl,
   Slope Stability in Surface Mining Society for Mining, Metallurgy, and Exploration, Inc
3. HUDSON, J.A. & HARRISON, J.P. (1997). Engineering Rock Mechanics: an Introduction to the Principles. Elsevier

	L -T- P
MNL 512 Advanced Engineering Geology	**3-0-2**

Course Objective:

- To provide advance knowledge of geological aspects of surface and underground excavation

Content:

Review of basic aspects of applied geology commonly employed in engineering geology, including map construction and interpretation, section construction, three-dimensional reconstructions, rock and mineral identification, interpretation of borehole logs, stereonets

Ground profiles and ground investigation: Significance of ground profiles to engineering design, their origin in various geological settings, their investigation, the engineering description of soils and rocks in profiles, and the interpretation of profiles. Design and execution of ground investigation, the recording of data, its assessment and use in creating a conceptual model of the ground, and the implications of such data for the costs and benefits of further investigation.

Engineering geology of soils and rocks: Formation, accumulation and geotechnical characters of soils found on land and in rivers, estuaries and lakes, in tropical, arid and glacial environments. Formation and geotechnical character of intrusive and extrusive igneous rocks, metamorphic and sedimentary rocks, and the problem of rock-head.

Neotectonic processes and brittle fracture in rock: The character and origin of neotectonic processes, geological evidence of such processes, means of dating and determining their rate of movement. Nature of jointing, generation of fractures and their relationship to burial, exhumation and in situ stress.

Hydrogeological principles: The definition, measurement and quantification of head, the natural parameters controlling hydraulic conductivity and the transmissivity, storage and quality of groundwater, quantification of flow in pores and fissures by various methods, the assessment of field parameters, wells and water supply, the control of groundwater in surface and underground works.

Remote sensing and GIS : General character of remotely sensed images relevant to the ground investigation of naturally occurring phenomena. Includes aerial photography, airborne line-scan systems and satellite imagery. Processing of remotely sensed digital data for engineering purposes. Introduction to Geographical Information System, preparation of GIS for engineering design

Engineering seismology : Introduction. Earth structure and plate tectonics, strain accumulation, elastic rebound and faulting. Energy release and seismic waves. Physical parameters of the earthquake source: hypocentre, magnitude, seismic moment and fault plane solution. Geological and seismological input for seismicity evaluation on magnitude-frequency relations.. Seismic hazard analysis and estimation of design ground motions. Ground rupture, tsunamis. Basic concepts of codes for earthquake-resistant design.

Books:

1. Judd, Engineering geology

2. Bell, Engineering geology

		L -T- P
MNL 513	**Instrumentation in Excavation**	**3-0-0**

Course Objective:

- To impart knowledge of various instrument used for measurement and monitoring in surface and underground excavation

Content:

Introduction to various instruments in excavation, electronic and manual data generation

Bore hole logging system, acoustic/ultrasonic instruments, ground penetrating radars

Stress and strain, deformation, convergence measuring instruments, Seismic instruments

Concrete testers, non-destructive instruments for excavations, Instrumentation for performance monitoring

Instrumentation for investigations:
Field investigations for selection and design of mechanical excavators and drilling systems

Data loggers, Automated data acquisition, analysis and interpretation

Books:

1. Whittaker, B. N. and Frith, R. C. (1990): Tunneling: Design, Stability and Construction, London: Institution of Mining and Metallurgy

2. Hoek, E and Brown, E.T. (1980):Underground Excavation in Rock, The Institution of Mining and Metallurgy, London

3. Bieniawski, Z. T. (1984):Rock Mechanics Design in Mining and Tunneling, Balkema.

4. John Dunnicliff Geotechnical Instrumentation for Monitoring Field Performance Lexington, Massachusetts

		L -T- P
MNL 514	**Grouting Technology**	**3-0-0**

Course Objective:

- To make student conversant about application of different types of grouts and its properties used excavation

Content:

Principles, purpose and application of grouting, viscosity and thixotropy of grout, flow of grout in cracks, pressures for grouting, utility for control of water movement, strengthening of both soil and rock, and structural applications.

Grouts: Types of grout : cement, chemical, cellular grout, silica fume modified grouts and microfine cement, additives: properties, application, setting of grout, durability

Grouting : Grouting techniques : injection techniques, jet, displacement, and permeation. Mix preparation, grout quality. Procedure of grouting assessment during and after grouting, Water testing in grout holes, Monitoring and control methods. Grouting in surface and sub-surface excavations

Grouting equipment: drilling and grouting equipment, grouting mixers, agitators, pumps, valves, pressure gauges, fittings on grout holes, grouting arrangement

Site investigation, geology, permeability and grouting design Grouting in stressed rock, computer aided grouting

Compaction, Remediation, and Testing of grout : field and laboratory studies related to grouting materials, Grouting verification methods and related technologies. Compaction grouting : mechanisms; theories, practice; effect of fines in compaction grouts. Remediation grouting: mine subsidence, cement grouting of dam joints.

Books:

1. C. Houlsby; Construction and Design of Cement Grouting : A Guide to Grouting in Rock Foundations(April 1990) John Wiley & Sons (Sd); ISBN: 0471516295

2. Robert Bowen**,** Grouting in engineering practice

	L -T- P
MNL 515 Concrete and shotcrete Technology	**3-0-0**

Course Objective:

- To provide knowledge of concrete and shortcrete application in excavation
- To make student aware about properties and design of concrete in excavation

Content:

Concrete Making Materials: Aggregates classification, IS Specifications, Properties, Grading, Methods of combining aggregates, specified, grading, Testing of aggregates, Fibers. Cement, Grade of cement, Chemical composition, Testing of concrete, Hydration of cement, Structure of hydrated cement, Special cements - Water Chemical admixtures, Mineral admixture.

Mix Design: Principles of concrete mix design, Methods of concrete mix design, Testing of concrete. Aggregates, Mixing water and admixtures, Formwork, Reinforcement, Concrete production (including ready-mixed concrete)

Concrete: Properties of fresh concrete, Hardened concrete, Strength, Elastic properties, Creep and shrinkage, Variability of concrete strength. Materials for concrete, Receiving and storing materials, Batching, mixing. Transporting, placing and compacting, Finishing and surface preparation, Protection and curing, Formwork and reinforcement, Sand-cement mixes, durability of concrete

Special Concrete: Light weight concrete, Fly ash concrete, Fibre refinforced concrete, Polymer Concrete, Super plasticised, concrete, Epoxy resins and screeds for rehabilitation - Properties and Applications - High performance, Mass concrete, Hot and cold weather concreting, Defects and repairs, Concrete pavements, Introduction to prestressed concrete, Vaccum dewatering - underwater concrete.

Concrete Floors on the Ground: Design philosophy, Subgrades and subbases, Joints.

Shotcrete technology: Introducing sprayed concrete, Materials for shotcrete including fibres, Properties of shotcrete (fresh and hardened), Mix design, Batching and mixing, Quality control, Equipment selection and maintenance, Planning and logistics

Books::

1. Neville, A.M., Properties of Concrete , Pitman Publishing Limited, London.
2. Shetty M.S., Concrete Technology, S.Chand and Company Ltd. Delhi.
3. Rudhani G., Light Weight Concrete Academic Kiado, Publishing Home of Hungarian Academy of Sciences, 1963.