**MINING ENGINEERING SYLLABUS**

Third Semester

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Sl. No | Course Name | Subject Code | Class Load/Week | Credit | Class Load/ week | Marks |
| L | T | P |  |  |  |
| 1. | Mathematics – III  |  | 3 | 0 | 0 | 3 | 3 | 100 |
| 2. | Electrical machines and power system in mines | MN2101 | 3 | 1 | 0 | 4 | 4 | 100 |
| 3. | Exploration and Shaft Sinking | MN2102 | 3 | 0 | 0 | 3 | 3 | 100 |
| 4. | Mine Support | MN2103 | 3 | 0 | 0 | 3 | 3 | 100 |
| 5. | Drilling and Blasting | MN2104 | 3 | 0 | 0 | 3 | 3 | 100 |
|  | **THEORY SUB-TOTAL** |  | **15** | **1** | **NIL** | **16** | **16** | **500** |
| 6. | Electrical machines and power system in mines lab  | MN2171 | 0 | 0 | 3 | 2 | 3 | 50 |
| 7. | Mine visit | MN2172 | 0 | 0 | 3 | 2 | 3 | 50 |
| 8. | Modelling & Simulation Lab | MN2173 | 0 | 0 | 3 | 2 | 3 | 50 |
| 9. | Seminar/Minor Project | MN2191 | 0 | 0 | 0 | 2 | 0 | 50 |
|  | **PRACTICAL SUB-TOTAL** |  | **0** | **0** | **9** | **8** | **9** | **200** |
|  | **Third Semester Total**  |  |  |  | **24** | **25** | **700** |

Fourth Semester

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Sl. No | Course Name | Subject Code | Class Load/Week | Credit | Class Load/ week | Marks |
| L | T | P |  |  |  |
| 1. | Geology  | MN2201 | 3 | 0 | 0 | 3 | 3 | 100 |
| 2. | Heat Power and theory of Machines | MN2202 | 3 | 1 | 0 | 4 | 4 | 100 |
| 3. | Fluid Mechanics and Fluid Machines | AM2202 | 3 | 0 | 0 | 3 | 3 | 100 |
| 4. | Underground Coal Mining | MN2204 | 3 | 0 | 0 | 3 | 3 | 100 |
| 5. | Underground Mine Environment | MN2205 | 3 | 0 | 0 | 3 | 3 | 100 |
|  | **THEORY SUB-TOTAL** |  | **15** | **1** | **0** | **16** | **16** | **500** |
| 6. | Geology Lab  | MN2271 | 0 | 0 | 3 | 2 | 3 | 50 |
| 7. | Heat Power and theory of Machines Lab | MN2272 | 0 | 0 | 3 | 2 | 3 | 50 |
| 8. | Fluid Mechanics Lab | AM2272 | 0 | 0 | 3 | 2 | 3 | 50 |
| 9. | Underground mine environment Lab | MN2274 | 0 | 0 | 3 | 2 | 3 | 50 |
|  | **PRACTICAL SUB-TOTAL** |  | **0** | **0** | **12** | **8** | **12** | **200** |
|  | **Fourth Semester Total**  |  |  |  | **24** | **28** | **700** |

Fifth Semester

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Sl. No | Course Name | Subject Code | Class Load/Week | Credit | Class Load/ week | Marks |
| L | T | P |  |  |  |
| 1. | Mine Ventilation Engineering | MN3101 | 3 | 1 | 0 | 4 | 4 | 100 |
| 2. | Surface Mining | MN3102 | 3 | 1 | 0 | 4 | 4 | 100 |
| 3. | Surveying | MN3103 | 3 | 1 | 0 | 4 | 4 | 100 |
| 4. | Geostatistics  | MN3104 | 3 | 0 | 0 | 3 | 3 | 100 |
| 5. | Underground Mining Machinery | MN3105 | 3 | 0 | 0 | 3 | 3 | 100 |
|  | **THEORY SUB-TOTAL** |  | **15** | **3** | **0** | **18** | **18** | **500** |
| 6. | Mine Ventilation Engineering Lab | MN3171 | 0 | 0 | 3 | 2 | 3 | 50 |
| 7. | Surveying Practical | MN3172 | 0 | 0 | 3 | 2 | 3 | 50 |
| 8. | Industrial training/Internship Evaluation | MN3191 | 0 | 0 | 3 | 2 | 3 | 50 |
|  | **PRACTICAL SUB-TOTAL** |  | **0** | **0** | **9** | **6** | **9** | **150** |
|  | **Fifth Semester Total**  |  |  |  | **24** | **27** | **650** |

*Sixth Semester*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Sl. No | Course Name | Subject Code | Class Load/Week | Credit | Class Load/ week | Marks |
| L | T | P |  |  |  |
| 1. | Metalliferous Mining  | MN3201 | 3 | 1 | 0 | 4 | 4 | 100 |
| 2. | Opencast Mining Machinery | MN3202 | 3 | 1 | 0 | 4 | 4 | 100 |
| 3. | Rock Mechanics | MN3203 | 3 | 0 | 0 | 3 | 3 | 100 |
| 4. | Environmental Engineering of Mines | MN3204 | 3 | 0 | 0 | 3 | 3 | 100 |
| 5. | Mine management Legislation and general safety | MN3205 | 3 | 0 | 0 | 3 | 3 | 100 |
|  | **THEORY SUB-TOTAL** |  | **15** | **2** | **NIL** | **17** | **17** | **500** |
| 6. | Design of Mining Layout | MN3271 | 0 | 0 | 3 | 2 | 3 | 50 |
| 7. | Rock mechanics Lab | MN3272 | 0 | 0 | 3 | 2 | 3 | 50 |
| 8. | Environmental Engineering of mines Lab | MN3273 | 0 | 0 | 3 | 2 | 3 | 50 |
|  | **PRACTICAL SUB-TOTAL** |  | **NIL** | **NIL** | **9** | **6** | **9** | **150** |
|  | **Sixth Semester Total**  |  |  |  | **23** | **26** | **650** |

*Seventh Semester*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Sl. No | Course Name | Subject Code | Class Load/Week | Credit | Class Load/ week | Marks |
| L | T | P |  |  |  |
| 1. | Mine and Mineral Economics | MN4101 | 3 | 0 | 0 | 3 | 3 | 100 |
| 2. | Coal and mineral beneficiation | MN4102 | 3 | 0 | 0 | 3 | 3 | 100 |
| 3. | Core Elective - I  | MN4121 | 3 | 0 | 0 | 3 | 3 | 100 |
| 4. | HSS III  |  | 3 | 0 | 0 | 3 | 3 | 100 |
|  | **THEORY SUB-TOTAL** |  | **12** | **0** | **NIL** | **12** | **12** | **400** |
| 5. | Coal and mineral beneficiation Lab | NN4171 | 0 | 0 | 3 | 2 | 3 | 50 |
| 6. | Mining Software lab | MN4172 | 0 | 0 | 3 | 2 | 3 | 50 |
| 7. | B.Tech Project/ Part - I | MN4173 | 0 | 0 | 2 | 4 | 2 | 100 |
| 8. | Internship (Evaluation) | MN4191 | 0 | 0 | 0 | 2 | 0 | 50 |
|  | **PRACTICAL SUB-TOTAL** |  | **0** | **0** | **8** | **10** | **8** | **250** |
|  | **Seven Semester Total**  |  |  |  | **22** | **20** | **650** |

**Core Elective – I**

MN 4121/1: Mine Safety and Ergonomics

MN 4121/2: Rock Slope Engineering

MN 4121/3: Geographical Information System

*Eighth Semester*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Sl. No | Course Name | Subject Code | Class Load/Week | Credit | Class Load/ week | Marks |
| L | T | P |  |  |  |
| 1. | Mine Planning and Design  | MN4201 | 3 | 1 | 0 | 4 | 4 | 100 |
| 2. | Core Elective – II | MN4202 | 3 | 0 | 0 | 3 | 3 | 100 |
| 3. | Open Elective – I |  | 3 | 0 | 0 | 3 | 3 | 100 |
|  | **THEORY SUB-TOTAL** |  | **9** | **1** | **0** | **10** | **10** | **300** |
| 4. | B.Tech Project/ Part - II | MN4271 | 0 | 0 | 2 | 8 | 2 | 200 |
| 5. | Seminar | MN4291 | 0 | 0 | 0 | 2 | 0 | 50 |
| 6. | Comprehensive Viva | MN4292 | 0 | 0 | 0 | 2 | 0 | 100 |
|  | **PRACTICAL SUB-TOTAL** |  | **0** | **0** | **8** | **12** | **2** | **350** |
|  | **Eight Semester Total**  |  |  |  | **22** | **12** | **650** |

**Core Elective II**

MN 4202/1: Material Handling and Transport

MN 4202/2: Remote Sensing and Image Processing

MN 4202/3: Environmental Impact Assessment and Management of Mining Projects

*Seventh Semester (DD)*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Sl. No | Course Name | Subject Code | Class Load/Week | Credit | Class Load/ week | Marks |
| L | T | P |  |  |  |
| 1. | Mine and Mineral Economics | MN4101 | 3 | 0 | 0 | 3 | 3 | 100 |
| 2. | Coal and mineral beneficiation | MN4102 | 3 | 0 | 0 | 3 | 3 | 100 |
| 3. | Rock Slope Engineering  | MN4121/2 | 3 | 0 | 0 | 3 | 3 | 100 |
| 4. | Mine System analysis and design | MN4122 | 3 | 0 | 0 | 3 | 3 | 100 |
| 5. | Open Elective -1 |  | 3 | 0 | 0 | 3 | 3 |  |
|  | **THEORY SUB-TOTAL** |  | **15** | **0** | **NIL** | **15** | **15** | **500** |
| 5. | Coal and mineral beneficiation Lab | MN4171 | 0 | 0 | 3 | 2 | 3 | 50 |
| 6. | Mining Software lab | MN4172 | 0 | 0 | 3 | 2 | 3 | 50 |
| 7. | Internship from 4th/6th Sem (Evaluation) | MN4191 | 0 | 0 | 0 | 2 | 0 | 50 |
|  | **PRACTICAL SUB-TOTAL** |  | **0** | **0** | **6** | **6** | **6** | **150** |
|  | **Seven Semester Total**  |  |  |  | **21** | **21** | **650** |

*Eighth Semester(DD)*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Sl. No | Course Name | Subject Code | Class Load/Week | Credit | Class Load/ week | Marks |
| L | T | P |  |  |  |
| 1. | Mine planning and Design | MN4201 | 3 | 0 | 0 | 3 | 3 | 100 |
| 2. | Material handling and Transport | MN4202/1 | 3 | 0 | 0 | 3 | 3 | 100 |
| 3. | Project management  | MN4203 | 3 | 0 | 0 | 3 | 3 | 100 |
| 4. | Ergonomics | MN4204 | 3 | 0 | 0 | 3 | 3 | 100 |
| 5. | Open Elective -II |  | 3 | 0 | 0 | 3 | 3 | 100 |
|  | **THEORY SUB-TOTAL** |  | **15** | **0** | **NIL** | **15** | **15** | **500** |
| 5. | M.Tech Project Part I (Term Paper) | MN4272 | 0 | 0 | 2 | 4 | 2 | 200 |
| 6. | Term paper seminar and viva voce | MN4293 | 0 | 0 | 0 | 2 | 0 | 100 |
| 7. | Comprehensive Viva | MN4294 | 0 | 0 | 0 | 2 | 0 | 100 |
|  | **PRACTICAL SUB-TOTAL** |  | **0** | **0** | **2** | **8** | **2** | **400** |
|  | **Seven Semester Total**  |  |  |  | **23** | **17** | **900** |

*Ninth Semester (DD)*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Sl. No | Course Name | Subject Code | Class Load/Week | Credit | Class Load/ week | Marks |
| L | T | P |  |  |  |
| 1. | Subsurface Rock Engineering and Tunneling | MN5101 | 3 | 0 | 0 | 3 | 3 | 100 |
|  | **THEORY SUB-TOTAL** |  | **3** | **0** | **0** | **3** | **3** | **100** |
| 5. | M.Tech Project Part II (Progress report) | MN5191 | 0 | 0 | 0 | 12 | 0 | 300 |
| 6. | Progress report seminar and viva voce | MN5192 | 0 | 0 | 0 | 6 | 0 | 100 |
|  | **PRACTICAL SUB-TOTAL** |  | **0** | **0** | **0** | **18** | **0** | **400** |
|  | **Seven Semester Total**  |  |  |  | **21** | **3** | **500** |

*Tenth Semester (DD)*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Sl. No | Course Name | Subject Code | Class Load/Week | Credit | Class Load/ week | Marks |
| L | T | P |  |  |  |
| 1. | M.Tech Final Project (Thesis) | MN5291 | 0 | 0 | 0 | 22 | 0 | 400 |
| 6. | Thesis seminar and viva voce | MN5292 | 0 | 0 | 0 | 8 | 0 | 200 |
|  | **PRACTICAL SUB-TOTAL** |  | **0** | **0** | **0** | **30** | **0** | **600** |
|  | **Seven Semester Total**  |  |  |  | **30** | **0** | **600** |

**DETAILED SYLLABUS**

*Eight semester B.Tech programme in Mining Engineering*

**3rd Semester**

Code Subject L T S

MN 2102 Exploration and Shaft sinking 3 0 0

## Expected Course Outcome:

After going through the course a student may be expected to

* explain the principles of exploration and know the various methods of exploration of minerals.
* be able to know the various equipment used for boring
* describe the various types of means of access to mineral deposits.
* explain rudimentary aspects of designing shafts/ inclines/ adits etc. and apply the knowledge in designin**g** means of access to mines.

**Syllabus**

|  |  |  |
| --- | --- | --- |
| Sl.No | Module name and topics | No. of Classes |
| 1 | **Exploration:** General, Objectives, Principles, Methods, Stages, Tracing and Cutting deposits; Exploration grids, Classification of Mineral Reserves, Surface Exploration and Subsurface Exploration. | 4 |
| 2 | **Mineral Exploration:** Stages, Geophysical methods and instruments, gravity, magnetism electromagnetism, resistivity of rocks and a number of different other variables, Locating Outcrop, Drilling- Diamond core drilling, Pitting, Trenching, Sampling, Assaying. | 5 |
| 3 | **Boring:** Introduction, Objectives, Methods- Percussive, Rotary; Core Recovery, Wire Line Drilling, Water Loss during Drilling, Underground Drilling, Bore hole deviation, Bore hole survey and Bore hole deflection, Difficulties in Boring | 5 |
| 4 | **Opening-up of Deposits:** Choice of mode of entry − adit, shaft, decline and combined mode, their applicability, number and disposition. Vertical and Inclined Shafts: Location, shape, size, and organisation of shaft sinking, construction of shaft collar, shaft fittings. | 5 |
| 5 | **Shaft Sinking Operations:** Ground breaking and muck disposal − tools and equipment, lining; ventilation, lighting and dewatering; sinking in difficult and water-bearing ground. Insets: Design, excavation and lining. | 5 |
| 6 | **Mechanised Sinking:** Simultaneous sinking and lining; slip - form method of lining; high speed sinking | 2 |
| 7 | **Shaft Boring:** Methods and equipment | 2 |
| 8 | **Layouts:** Layouts of pit-top and pit-bottom | 1 |
| 9. | **Special Attributes:** Widening and deepening of inclined and vertical shafts; staple shafts, raised shafts. | 1 |
|  | Total | 30 |

## Suggested Reading:

1. [Darling](http://www.amazon.com/Peter-Darling/e/B00J2XK6BE/ref%3Ddp_byline_cont_book_1) P. (Editor). 2011. *SME Mining Engineering Handbook*. Third edition. Society for Mining Metallurgy and Exploration. 1984 p.
2. Deshmukh D. J. (2010) *Elements of Mining Technology. Vol.1* (8th Edition). Denett and Company, Nagpur. 424 p.
3. Hartman H. L. and Mutmansky J. M. 2002. *Introductory Mining Engineering*, 2nd Edition. John Wiley. 584 p.
4. IMM. 2005. *Shaft Engineering*. Institution of Mining and Metallurgy, London in association with CRC Press. 405 p.
5. Marjoribanks, R.W. Geological Methods in Mineral Exploration and Mining, Chapman & Hall, London, 1997
6. Chugh, C.P. High Technology in Drilling and Exploration, Oxford & IBH, New Delhi, 1992
7. Rose, A.W. Hawkes, H.E. and Webb, J.S. Geochemistry in Mineral Exploration, Academic Press, London, 1979
8. Kuzvart, M. and Bohmer, M. Prospecting and Exploration of Mineral Deposits, Elsevier, Amsterdam, 1986
9. Edwards, R.P and Atkinson, K. Ore Deposit Geology and its Influence on Mineral Exploration, Chapman & Hall, New York, 1986

Code Subject L T S

MN 2103 MINE SUPPORT 3 0 0

### Full Marks: 100

## Expected Course Outcome:

After going through the course a student may be expected to

* Describe the fundamentals of support system design for both conventional and mechanised underground mines.
* Describe the fundamentals of stowing in underground mines

### Syllabus

|  |  |  |
| --- | --- | --- |
| Sl. No. | Module | No. of Classes |
| 1 | **Roof Supports**: Classification of coal seam roofs, theories of the mechanics of strata behaviour, Timber props and cogs; friction/hydraulic props and chocks; other steel supports;  | 5 |
| 2 | **Roof bolting**: Principle of roof bolting: Classification of types of roof bolts; function, applicability and advantage of roof bolting and cable bolting | 5 |
| 3 | **Self-Advancing Powered Supports:** classification, components, design aspects and safety features | 5 |
| 4 | **Fore poling, Roof stitching** | 2 |
| 5. | **Passive rock support:** Shot creating, Steel arching | 2 |
| 6 | **Systematic Support Rules**; supporting scheme of development gallery, Bord and Pillar and Longwall faces, depillaring district; withdrawal of support. | 5 |
| 7 | **Stowing:** Conditions requiringstowing in mines; types of stowing; suitable materials for hydraulic stowing; stowing plant and stowing range; hydraulic gradient and hydraulic profile. | 6 |
| **TOTAL** | 30 |

#### Suggested Reading:

1. [Darling](http://www.amazon.com/Peter-Darling/e/B00J2XK6BE/ref%3Ddp_byline_cont_book_1) P. (Editor). 2011. *SME Mining Engineering Handbook*. Third edition. Society for Mining Metallurgy and Exploration. 1984 p.
2. Deshmukh D. J. (2010) *Elements of Mining Technology. Vol.1* (8th Edition). Denett and Company, Nagpur. 424 p.
3. Hartman H. L. and Mutmansky J. M. 2002. *Introductory Mining Engineering*, 2nd Edition. John Wiley. 584 p.
4. IMM. 2005. *Shaft Engineering*. Institution of Mining and Metallurgy, London in association with CRC Press. 405 p.
5. Mukherjee S N (1993) - *Longwall Machinery and Mechanisation*. A.M. Publishers. Dhanbad. 431p.
6. Peng S. S. (2006) - *Longwall Mining*. Second edition. Published by Syd S. Peng. 636p.
7. Singh R D (1997) *Principles and Practices of Modern coal Mining*. New Age Publisher, New Delhi.720 p.

Code Subject L T S

MN 2104 DRILLING AND BLASTING 3 0 0

### Full Marks: 100

## Expected Course Outcome:

After going through the course a student may be expected to

* Explain the principles of rock drilling and design both production-drilling systems for various mining conditions.
* Be able to select appropriate drilling equipment and accessories suitable to site-specific conditions in both underground and surface mines.
* Explain basic characteristics of explosives and describe rock breakage mechanism in blasting.
* Design appropriate blasting rounds for various types of mines and rocks.

### Syllabus

| Sl. No. | Module Name and topics | No. of Classes |
| --- | --- | --- |
| 1 | **Principles of Drilling**: Principles of rock drilling, drillability, and mechanics of drilling. Different exploratory and production drilling systems- classification and equipments | 04 |
| 2 | **Drill Bits:** Various types of drill bits. Thrust feed and rotation, alignment and deviation in drilling | 02 |
| 3 | **Oil and Gas Drilling:** components of drill rigs, rods, casing, mud systems, and monitoring, directional drilling | 04 |
| 4 | **Explosives:** Properties of explosives. Different low and high explosives, Bulk Explosive systems  | 04 |
| 5 | **Accessories to Explosives:** Fueses, detonators, and shock tube initiation system | 02 |
| 6 | **Blasting Methods:** Systems of blasting in underground and surface mines. Misfires, blown out shots, incomplete detonation- causes and remedial measures. Secondary and Controlled Blasting techniques.  | 04 |
| 7 | **Blast Design:** Design of blasting rounds in underground and surface mines  | 04 |
| 8 | **Handling of Explosives:** Transport of explosives, storage and handling | 02 |
| 9 | **Alternate Rock Breaking systems:** Substitutes for explosives and their applications-hydrox, Cardox, Hydraulic coal burster, airdox, pulsed infusion shot firing. | 02 |
| 10 | **Mechanics of Blasting:** Factors affecting rock breakage, Crater theory and its applications, theories of rock breakage using explosives.  | 02 |
|  | TOTAL | 30 |

## Suggested Reading:

1. Das S. K. 2001. *Explosives and Blasting Practices in Mines*. Lovely Prakashan, Dhanbad.
2. Fanchi J. R., Arnold K., Clegg J D, Holstein E. D. and Warner H. R. 2007. *Petroleum Engineering Handbook: Drilling Engineering*. Society of Petroleum Engineers. 763 p.
3. Konya K. J. and Walter E. J. 1990. Surface Blast Design. Prentice Hall. 303 p.
4. Mitchell R. F. and Miska S. 2010. Fundamentals of Drilling Engineering. Society of Petroleum Engineers.696 p.
5. Pradhan G. K. and Sandhu M. S. 2002. *Blasting Safety Manual*. IME Publications, Calcutta. 271 P.

**4th Semester**

**Code Subject L T S**

**MN2204: UNDERGROUND COAL MINING 3 0 0**

**Full Marks: 100**

## Expected Course Outcome:

After going through the course a student may be expected to:

* explain the unit operations in mining and choice of working methods.
* demonstrate the ability to elucidate both development and depillaring operations in bord and pillar method of coal mining.
* carry out simple design exercises in relation to above
* explain the method of longwall mining and its design aspects, process of development, face machineries, operations and salvaging process.
* elucidate various types of stowing systems applied in underground coal mines.

**Syllabus**

|  |  |  |
| --- | --- | --- |
| **Sl. No**. | **Modules and topics** | **No. of Classes** |
| 1. | **Indian mining conditions and conditions suitable for Bord & Pillar mining, Mine unit operations**In seam and horizon mining systems | 01 |
| 2. | **Concept on Panel,** inter panel barriers, Pillar sizes, Size of the mine and related calculations, Relevant regulations | 02 |
| 3. | **Different layouts of Bord & Pillar mine**, possible variations with change in production performance. | 02 |
| 4. | **Preparatory arrangements before depillaring operation**, Flow diagram on steps of depillaring, types of mine plans required to be maintained during depillaring operation. | 02 |
| 5. | **Line of operation**, different types of line of operation- merits and demerits, sequence of pillar extraction and conditions governing pillar extraction, concept on goaf line velocity and its importance, relevant coal mine regulations. | 02 |
| 6. | **Support requirement during depillaring**- techniques of setting and withdrawal of supports, relevant regulations and circulars. | 02 |
| 7. | **Possible hazards during extraction of pillars**- remedial measures | 02 |
| 8. | **Development of panel with SDL, LHD, Scraper- merits and demerits** | 02 |
| 9. | **Coal face mechanization** – advantages and disadvantages, various other measures to improve production performance. | 02 |
| 10 | **Longwall mining:** applicable condition, types, layout, parameter, conventional & mechanized longwall; strata behaviour, types of fall, support resistance, mean load density, coal evacuation circuit; AFC, stage loader, lump breaker, gate-belt, coal preparing machine; shearer, coal plough, salvaging operation; salvaging chamber preparation, removal, loading & transportation of support, etc. | 10 |
| 11 | **Stowing**: application | 03 |
|  | **Total** | **30** |

**Suggested Reading:**

1. Darling P. (ed). 2011. *SME Mining Engineering Handbook*, Third Edition. Society for Mining, Metallurgy, and Exploration, Liitleton. CO,1840 pages
2. Das S. K. 1994. *Modern Coal Mining Technology*, Second Edition. Lovely Prakashan, Dhanbad
3. Deshmukh D. J. 2010. *Elements of Mining Technology* Vol. 1. 8th Edition. Denett & Company, Nagpur. 424 pages
4. Hartman H. L. and Mutmansky J. M. 2002. *Introductory Mining Engineering*. John Wiley & Sons. 570 pages.
5. Peng S. S. 2006. *Longwall Mining*. Second edition. Published by Syd S. Peng. 636p.
6. Singh J. G. 2000. *Underground Coal Mining Methods*. Braj-Kalpa Publishers. Varanasi, India. 538 pages.
7. Singh R.D. 2005. *Principles and Practices of Modern Coal Mining*. New Age International. 696 pages

**Code Subject L T S**

**MN2205: UNDERGROUND MINE ENVIRONMENT 3 0 0**

**Full Marks: 100**

**Expected Course Outcome:**

After going through the course a student may be expected to:

* narrate and explain the composition and characteristics of mine atmosphere and the properties and physiological effects of its constituents.
* identify the sources of dust and explain the hazards associated with mine dust. Design campaign for dust measurement in mines and carry out the same. Design effective measures for dust suppression and control.
* identify possible sources of fires in underground coal-mine and take precautions and safety measures against occurrence of fire. They should also be able to take measures for dealing with underground mine.
* identify possible sources of inundation in a mine and take precautions measures for prevention of mine inundation.
* identify causes of mine explosion; design and execute effective action plans for rescue and recovery operations in mines.

**Syllabus**

|  |  |  |
| --- | --- | --- |
| **Sl. No.** | **Modules and topics** | **No. of Classes** |
| 1 | **Composition of mine atmosphere and Mine gases**: composition of atmospheric air, impurities in mine air; noxious gases - properties, physiological effects, and analysis, dust, suspended liquid droplets, solid impurities, etc. | 3 |
| 2 | **Mine climate:** heat and humidity: air pressure, temperature, moisture, cooling power of mine air and its improvement, refrigeration, effective temperature, WBGT etc. | 2 |
| 3 | **Dust:** Sources of dust in mines, dust hazards, collagenous and non-collagenous dust properties, dust particle sizes responsible to respiratory diseases and possible measures to combat the problems.  | 2 |
| 4 | **Measurement of dust and its prevention:** MAC of dust, measures to limit production of airborne dust and prevention of LAP of dust. Stone dust barriers – types, construction and erection. Related statutes from CMR 1957. | 4 |
| 5 | **Dust Abetment:** Various control measures of dust and scheme developed on dust monitoring, control and sampling in mines (pre and post dusting period). | 2 |
| 6 | **Fire:** Possible sources of fire in mines and their precautionary measures in surface and underground, Statutes on mine fire and spontaneous heating. | 3 |
| 7 | **Inundation:** Potential sources of mine inundation, concept on naturally wet and abnormal seepage in relation to mines, measures to restrict inundation related problems, relevant statutes on different conditions imposed on working susceptible to inundation. | 3 |
| 8 | **Mine explosions:** causes, prevention, and control: firedamp explosion & coal dust explosion, explosive limit, affecting factors, characteristics, etc. | 4 |
| 9 | **Rescue and Recovery operations:** human respiratory system, mine rescue apparatus, rescue organization, rescue stations & rescue rooms, recovery work , etc. | 2 |
| 10 | **Illumination:** standards and arrangements: concepts, statutory provisions, arrangements in opencast & in underground mines, etc.  | 3 |
| 11 | **Class Tests** | 2 |
|  | **Total** | **30** |

**Suggested Reading:**

1. Banerjee S P (2003): *Mine Ventilation.* Lovely Prakashan, Dhanbad. 457p
2. Deshmukh D.J. (2010): *Elements of Mining Technology* Vol. 2. (8th Edition). Denett & Company, Nagpur. 424p
3. Hartman H L, Mutmansky J M, Ramani R V and Wang Y J (1997): *Mine Ventilation and Air Conditioning* (3rd edition)*.* John Wiley and Sons. 730p
4. ILO (1986): *Safety and Health in Coal Mines: An ILO Code of Practice*. International labour Office Geneva. 176p
5. Kaku L C (2002): *Numerical Problems on Mine Ventilation – Coal and Metal.* 186
6. McPherson M J (1993): *Subsurface Ventilation Engineering* (web edition)*.* Downloadable from <http://www.mvsengineering.com>
7. McPherson M J (2009): *Subsurface Ventilation and Environmental engineering* (2nd edition)*.* Chapman and Hall, 824p
8. Misra G B (1986): *Mine Environment and Ventilation*. Oxford University Press. 619p
9. Misra G B (2001*)*: *Problems on Mine Ventilation*. Geeta Book Stores, Dhanbad. 213p
10. Ramlu M A (2007): *Mine Disasters and Mine Rescue*. (2nd Edition). Universities Press, Hyderabad. 448p

**5th Semester**

**Code Subject L T S**

**MN3101: Mine Ventilation Engineering 3 1 0**

**Full Marks: 100**

## Expected Course Outcome

After going through the course a student may be expected to

* explain mine ventilation related phenomena, particularly the laws governing flow of air to different underground locations, in terms of the principles of fluid mechanics,
* estimate the amount of fresh air required at various places in underground workings,
* explain turbo-mechanic principles of mine fans and select appropriate fans for underground mines,
* explain the functioning of various instruments used in ventilation survey,
* solve problem relating to simple and complex ventilation networks and design appropriate mine ventilation network,
* carry out elementary level mine ventilation planning.

## Syllabus

|  |  |  |
| --- | --- | --- |
| **Sl. No**. | **Module Name and topics** | **No. of Classes** |
| 1 | **Introduction: –** Purpose and importance; Historical overview | 1 |
| 2 | **Main Elements of Ventilation:–** Standards of ventilation. Permissible air velocities in different types of workings/openings. | 3 |
| 3 | **Air Flow Through Mine Openings: –** Review of Fluid Mechanics -types of fluid flow, Poiseuille’s equation, Chezy-D’Arcy equation; Atkinson’s equation and the square law, Resistance in series and parallel, equivalent Orifice; Power requirement for air flow and ways for its reduction; Shock Pressure Loss; shock losses due to obstructions, formation of wake, variation of drag coefficient, losses due to bends and area changes | 6 |
| 4 | **Natural Ventilation: –** Natural ventilation Pressure in shafts, direction and amount of natural ventilation, motive column; Calculation of NVP and motive column; Thermodynamic aspects of mine airflow | 4 |
| 5 | **Mechanical Ventilation: –** Devices, characteristics, selection; Auxiliary and booster ventilation; Centrifugal fan - theoretical head, volute, power requirement; Axial flow fan - pressure developed, losses in fans; Fan characteristic curves, operating point; Selection of Fan; Auxiliary and booster ventilation | 10 |
| 6 | **Ventilation Survey: –** Quantitative and qualitative survey, related laws, selection of stations, instruments | 3 |
| 7 | **Ventilation Control Devices: –** Distribution of air current - airlock, ventilation stopping, air crossings advantages of splitting; Auxiliary Ventilation - forcing, exhaust and overlap ventilators, precautions against recirculation; Booster fan - advantages and disadvantages, location of booster fans, critical pressure, related laws | 9 |
| 8 | **Ventilation Planning: –** Planning of ventilation systems and economic considerations;Ventilation layouts for underground coal and metal mines; Calculation of air quantity required for ventilating a mine, calculation of total mine head; Ventilation network analysis - principles and computer applications. | 4 |
| **TOTAL** | **40** |

## Suggested Readings

1. Banerjee S P (2003): *Mine Ventilation.* Lovely Prakashan, Dhanbad. 457p
2. Ganguli R and Bandopadhyay S (2004): *Mine Ventilation*. Taylor & Francis. 536p.
3. Hartman H L, Mutmansky J M, Ramani R V and Wang Y J (1997): *Mine Ventilation and Air Conditionin*g (3rd edition)*.* John Wiley and Sons. 730p
4. Kaku L C (2002): *Numerical Problems on Mine Ventilation – Coal and Metal.* 186p
5. McPherson M J (1993): *Subsurface Ventilation Engineering* (web edition)*.* Downloadable from <http://www.mvsengineering.com>
6. McPherson M J (2009): *Subsurface Ventilation and Environmental engineering* (2nd edition)*.*Chapman and Hall, 824p
7. Misra G B (2001*): Problems on Mine Ventilation*. Geeta Book Stores, Dhanbad. 213p

**Code Subject L T S**

**MN3102: Surface Mining 3 1 0**

**Full Marks: 100**

## Expected Course Outcome

After going through the course a student may be expected to

* apply the knowledge about different design features of an opencast mine to carry out rudimentary level planning and design,
* explain the principles and concepts of mine layouts under varied site specific geo-mining conditions,
* plan design and execute various unit operations in an opencast mine.

## Syllabus

| Sl. No. | Module Name and Topics | No. of Classes |
| --- | --- | --- |
|  | **Introduction:** **–** Current status and future trends in production; Productivity and technological developments; Surface mining methods **-**classification, applicability; Factors and conditions affecting selection; Advantages and disadvantages | 02 |
|  | **Planning and Design of Surface Mines:** **–** Definition of mining parameters -bench height, pit slopes, cut-off grade, strip ratio; Ultimate pit definition - manual and computer methods, Lerchs-Grossman method, incremental pit expansion, floating cone method; Waste disposal -planning, design, construction, stability, and environmental protection aspects | 05 |
|  | **Opening up of Deposits:** **–** Surface preparations; Box cut - objective, types, parameters, methods; Factors affecting selection of box cut site; Production benches - formation, parameters and factors affecting their selection. | 04 |
|  | **Preparation for Excavation:** **–** Ripper - applicability and limitations; Concept of rippability - method and cycle of operation, estimation of output;. Blast hole drilling - estimation of number of drills required for a given mine production. | 02 |
|  | **Blasting:** **–** Design of blasting rounds- general considerations, blast pattern and delay selection, explosive consumption; Blasting mechanics; Design guidelines | 04 |
|  | **Discontinuous/Cyclic Methods of Excavation and Transport:** **–** Shovel-dumper operation - cycle time and productivity calculation, fleet size estimation, application of shovel-dumper combination in various types of deposits; Dragline operation - applicability and limitations, different modes of operation, reach calculation, cycle time and productivity calculation; Calculation of bucket capacity; Scrapers - applicability and limitations, various types, method and cycle of operation, pusher dozer and push-pull operation; Dozers - applicability and limitations, types and classification, types of blade and corresponding merits and demerits, method and cycle of operation; Front-end-loaders - applicability and limitations, method and cycle of operation, concept, estimation and significance of minimum tipping- load, calculation of maximum working load and selection of bucket capacity. | 08 |
|  | **Continuous Methods of Excavation and Transport:** **–** Bucket wheel excavators - applicability and limitations, types and principle of operation, half and full block methods and their corresponding merits and demerits, productivity calculation; Continuous surface miners - types, classification, applicability and limitations, principles of operation, classification of operational methods - wide / full bench method, block mining method and stepped cut method, empty travel back method, turn back method and continuous mining method, conveyor/ truck loading method, side casting method and windrowing method, merits, demerits, applicability and limitations of these methods; Conveyors -shiftable and high angle conveyors, mode of operation, merits, demerits, applicability and limitations. | 06 |
|  | **Semi-Continuous Methods of Excavation and Transport:** **–** Continuous excavation and partly/fully cyclic transport system - different methods and applicability and limitations; Cyclic excavation and partly/fully continuous transport system, - different in-pit crushing and conveying methods and their respective applicability and limitations. | 06 |
|  | **Dimensional Stone Mining:** **–** Dimensional stones - types, occurrences and uses, methods vis-à-vis equipment for extraction of primary blocks in granite and marble quarries | 03 |
| **TOTAL** | **40** |

## Suggested Readings

1. Hustrulid W A (2005) Blasting Principles for Open Pit Mining. Set of 2 Volumes, Volume 1: General Design Concepts Volume 2: Theoretical Foundations. Taylor & Francis. 1032p.
2. Hustrulid W and Kuchta M and MartinR K (2013) Open Pit Mine Planning and Design. 3rd edition. (Two Volume Set & CD-ROM Pack) CRC Press. 1500p
3. Kennedy B A (Editor) (1990): Surface Mining, 2nd Edition. Society for Mining, Metallurgy, and Exploration, Littleton, CO, USA. 1206 pages
4. Rzhevsky V V (1985): Opencast Mining: Unit Operations. Mir Publishers, Moscow. 479p
5. Rzhevsky V V (1987) Opencast Mining: Technology and Integrated Mechanization. Mir Publishers, Moscow. 495p

**Code Subject L T S**

**MN3103: Surveying 3 1 0**

**Full Marks: 100**

## Expected Course Outcome

After going through the course a student may be expected to

* explain the method of linear measurements, the instruments used and accuracy,
* explain the method of angular measurements processes particularly the adjustment of traverse,
* solve problems related to levelling,
* estimate the topological undulations by contouring,
* explain the process of correlation,
* solve problems on volumes, dip and fault.

## Syllabus

|  |  |  |
| --- | --- | --- |
| Sl. No. | Modules and Topics | No. of Classes |
| 1. | **Introduction**: **–** Importance and application; Principles of surveying | 02 |
| 2. | **Linear Measurements**: **–**Linear measurements using various instruments; Errors in measurement; Triangulation,  | 02 |
| 3. | **Angular Measurements**: **–**Basic construction of theodolite; Different methods of angle measurements using theodolite. | 04 |
| 4. | **Traversing**: **–**Concept of bearing, open and closed traverse, compasses and traversing with compass, traversing with theodolite, traverse calculations, error corrections and adjustments | 10 |
| 5. | **Leveling**: **–**Principles and concepts of leveling, construction of different leveling instruments; Leveling calculations and adjustments; Different types of levelling -reciprocal leveling, trigonometric leveling | 06 |
| 6. | **Contouring**: **–**Fundamental principles and concepts, field measurements and generation of contours | 02 |
| 7. | **Development in Surveying Instrumentation**: **–** GPS, Total Station, EDM. | 04 |
| 8. | **Correlation**: **–**Single and double shaft methods, precautions taken and equipment used. | 04 |
| 9. | **Plans and Sections**: **–**Different plans and sections in mines | 02 |
| 10. | **Area and Volume computation and dip fault problems** | 04 |
| **Total** | **40** |

## Suggested Reading

1. Bannister A., Raymond S. and Baker R. 1998. *Surveying*, Pearson Education Ltd., 498p
2. Barry F., Kavanagh S.J. and Bird G. 1984, *Surveying: Principles and Applications*. Reston Publishing Company, 900p
3. Kanetkar T.P. and Kulkarni S.V. 2015.*Surveying and Leveling*. Vo I & II, Universities Press, 680p.
4. Madhu N, Sathikumar R. and. Gopi S.2006. *Advanced Surveying: Total Station, GIS and Remote Sensing.* Pearson Education India, 386P
5. Winniberg F. 1957.Metalliferous Mine surveying, Mining Publications Ltd., London. 402p.

**Code Subject L T S**

**MN3104: Geostatistics 3 0 0**

**Full Marks: 100**

## Expected Course Outcome

After going through the course a student may be expected to

* use various interpolation methods and associated mathematical concepts in problem solving.
* explain the concepts of semi variogram, regularization, dispersion variance and estimation variance.
* carry out simple kriging and solve mathematical problems on kriging.
* carry out ore reserve estimation using kriging.

## Syllabus

|  |  |  |
| --- | --- | --- |
| **Sl. No**. | **Module Name and topics** | **No. of Classes** |
| 1 | **Introduction to Spatial Statistics** | 02 |
| 2 | **Terminology:-** Regionalised (or spatial) variables, intrinsic hypothesis and second order stationarity condition | 02 |
| 3 | **Semivariogram**:- Definition and derivation of semivariogram and covariogram and their relationship, interpretation, linking semivariogram behaviour with physical causes (geology, sampling, nugget effect), Semivariogram modelling, semivariogram in aniosotropy, measurement in practical field. | 04 |
| 4 | **Regularization:-** Point sample and regularized sample; Average semivariogram; Relationship between point and block semivariogram and application; Auxiliary function | 04 |
| 5 | **Dispersion Variance:-**Definition, calculation, application, volume-variance relationship.  | 04 |
| 6 | **Estimation variance:-**Extension variances and estimation variances/simple calculations in one and two dimensions; Grade tonnage relationship. | 04 |
| 7 | **Kriging:-**Optimal estimation and introduction to kriging; Derivation of kriging error and kriging estimator; Comparison with estimation variance; Block kriging and point kriging. | 06 |
| 8 | **Practical Considerations and Practices** | 04 |
| **TOTAL** | **30** |

## Suggested Readings

1. Armstrong M. 1998.*Basic Linear Geostatistics* Springer Science and Business Media.155 p.
2. Bohling G. 2005. *Introduction to Geostatistics and Variogram Analysis*.Kansas Geological Survey. Available online at <http://people.ku.edu/~gbohling/cpe940/Variograms.pdf>.20 p.
3. Chiles J-P.and Delfiner P.J. 2012. *Geostatistics: Modeling Spatial Uncertainty*, 2nd edition. Wiley, 734 p.
4. Clark I. 1979.Practical Geostatistics. *Applied Science Publishers*, London.129 p. (also downloadable free from <http://www.kriging.com/pg1979_download.html>)
5. David M. 1982 *Geostatistical Ore Reserve Estimation*, 1st Edition. Elsevier.384 p.
6. Edward H. Isaaks E.H. and Srivastava R.M. 1989.*An Introduction to Applied Geostatistics*. Oxford University Press.561 p.
7. Goovaerts P. 1997.*Geostatistics for Natural Resources Evaluation*. Oxford University Press.483 p.
8. Hohn M.E. 1998. *Geostatistics and Petroleum Geology*. Springer Science and Business Media, 235 p.
9. Journel A.G. and Huijbregts Ch.J. 2003.*Mining Geostatistics*, Blackburn Press. 600 p.
10. Rendu J.M. 1981. *An introduction to Geostatistical Methods of Mineral Evaluation*. 2nd ed. South African Institute of Mining and Metallurgy, Johannesburg. 84 p
11. Stein M. 1999.*Interpolation of Spatial Data: Some Theory for Kriging*. Springer.247 p.

**Code Subject L T S**

**MN3105: Underground Mining Machinery 3 0 0**

**Full Marks: 100**

## Expected Course Outcome

After going through the course a student may be expected to

* explain the principles of operation of important mining machineries and devise strategies for enhancing utilization efficiencies of such machines,
* select appropriate fleet of machines for cyclic, semi-continuous and continuous systems of unit operations in mines,
* solve mathematical problems relating to excavation and transport machines,
* explain the salient features of construction, design and maintenance of excavators and material handling equipments.

## Syllabus

| Sl. No. | Module Name and topics | No. of Classes |
| --- | --- | --- |
|  | **Introduction:** **–** Classification and Selection of Mine Transport System – general selection criteria and their importance | 02 |
|  | **Haulage Systems:** **–** Types, layouts, calculations, regulatory provisions. | 04 |
|  | **Wire Ropes and Chains:** **–** Types, construction, care, condition monitoring, installation and removal, pre-stressing of ropes, fatigue and deterioration, regulatory provisions | 03 |
|  | **Conveyors:** **–** Basic features; Classification; Belt conveyor - description, layout, operational problems, capacity calculations, average loading factor and sequence control, merit and demerits; Scraper chain conveyor – types, layout and operating principle, advantages and disadvantages; Cable belt conveyors; Special types of conveyors. | 06 |
|  | **Mine Pumps:** **–** Working principles, basic components and operational features. | 02 |
|  | **Drills and Roof Bolters:** **–** Types, construction and mode of operation | 02 |
|  | **Compressors:** **–** Air-compressors - principles, types, construction, installation and maintenance; Compressed air transmission and distribution, compressed air drills, pneumatic picks, air motors and other compressed air equipment. Pneumatic chutes | 03 |
|  | **Winding System:** **–** Drum and friction winding, headgears, headgear pulleys, cages and skips, suspension gear, keps and guides; Steam and electric winders, safety devices in winders, duty cycle; Automatic winding, multilevel winding. | 06 |
|  | **Electrical Layouts:** **–** Electrical substation, gate-end box, layout of semi-mechanised and mechanised mines. | 02 |
| **TOTAL** | **30** |

## Suggested Readings

1. Chakrabarti P.K. 1999. *Electricity in Underground Coal Mining*. CMPDIL, Ranchi.297 p.
2. Datta N.K. 1996. Electrical Engineering in Mines. New Central Book Agency, Delhi. 239 p
3. De A. 2014.*Latest Development of Heavy Earth Moving Machinery*. Galgotia Publications Pvt. Ltd. 312 p.
4. Karelin N.T. 1967. *Mine Transport*. Orient Longmans, Calcutta. 193 p.
5. Khurmi R.S and Gupta. J.K. 2005.*A Text Book of Machine Design*. Eurasia Publishing House 1251 p
6. Martin J. W., Martine T.J., Bennett T.P., and Martin K.M. 1982. *Surface Mining Equipment*. Martin Consultants, Golden, CO. 455 p.
7. Popov G 1971. *The Working of Mineral Deposits*. Mir Publishers, Moscow. 616 p.
8. Shepherd R. and WithersA.G.1960. *Mechanized Cutting and Loading of Coal*. Odhams Press, 328 p.

**6th Semester**

**Code Subject L T S**

**MN3201: Metalliferous Mining 3 1 0**

**Full Marks: 100**

## Expected Course Outcome

After going through the course a student may be expected to

* explain the various development operations in a metal mine,
* explain the various stoping methods used in underground metal mines,
* carry out elementary level planning of an underground metal mining.

## Syllabus

| **Sl. No**. | **Module Name and topics** | **No. of Classes** |
| --- | --- | --- |
| 1 | **Driving /Crosscutting: –** Conventional -cycle of operation, equipment used and time cycle; Mechanised -cycle of operation, equipment used and time cycle. | 04 |
| 2 | **Raising: –** Conventional - cycle of operation, equipment used and time cycle; Mechanised - Long hole raising, raising by ALIMAK raise climber, raise boring | 04 |
| 3 | **Winzing: –** Cycle of operation, equipment used and time cycle | 01 |
| 4 | **Other Development Openings: –** Ore and waste bin; Ore pass; Shaft stations,  | 06 |
| 5 | **Underhand and Overhand Methods of Breaking Ore: –** Underhand and overhand principle; Underhand and overhand stoping. | 02 |
| 6 | **Breast Stoping: –** Application, method of stoping and equipment used | 02 |
| 7 | **Selection of Stoping Methods** | 01 |
| 8. | **Open Stoping Methods: –** Shrinkage stoping -application, development, stoping operations, ventilation, machinery used; Sublevel stoping -application, development, stoping operations, ventilation, machinery used. V.C.R. and blast hole stoping -application, development , stoping operations, ventilation, machinery used; Stope and Pillar stoping - application, development, stoping operations, ventilation, machinery used. | 06 |
| 9. | **Filled methods: –**Cut and fill stoping -application, development, stoping operations and machinery used; Variations of cut and fill - underhand cut and fill, overhand cut and fill and ‘post and pillar’stoping; Mechanical, hydraulic and pneumatic filling of stopes; Square set stoping - application, development, stoping operations and machinery used. | 06 |
| 10. | **Caving Methods of Stoping: –** Application, development, stoping operations and machinery used inblock caving and sublevel caving methods of stoping | 04 |
| 11. | **Metal mine planning: –**Scheduling; Basic planning of different unit operations in a metal mine. | 04 |
|  | Total | 40 |

## Suggested Readings

1. Darling P (ed.) (2011): *SME Mining Engineering Handbook, Third Edition*. Two Volume Set. Society for Mining, Metallurgy, and Exploration Inc. Littleton, CO, USA.1984 pages
2. Gertsch R. E. and Bullock R. L. 1998.*Techniques in Underground Mining: Selections from Underground Mining Methods Handbook*. Society for Mining, Metallurgy, and Exploration. 823 pages
3. Hartman H. L. (Editor). 1992. *SME Mining Engineering Handbook; 2nd edition*. Volume-1 and volume2. Society for Mining, Metallurgy, and Exploration. 2394 pages
4. Hustrulid W. A. and BullockR. A. (Eds). 2001. *Underground Mining Methods: Engineering Fundamentals and International Case Studies*. Society for Mining, Metallurgy, and ExplorationInc. Littleton, CO, USA.. 728 pages
5. Hartman H.L. and Mutmansky J.M. 2002. *Introductory Mining Engineering*. John Wiley & Sons. 570p.

**Code Subject L T S**

**MN3202: Opencast mining machinery 3 1 0**

**Full Marks: 100**

## Expected Course Outcome:

After going through the course a student may be expected to

* Explain the basic principles of operation of various earthmoving machinery
* Calculate capacity of various earthmoving machines
* Carryout equipment planning and select appropriate fleet of machinery for earthmoving operations.

## Syllabus

| **Sl. No**. | **Module Name and Topics** | **No. of Classes** |
| --- | --- | --- |
|  | **Earth Movers**:-Classification; Design Features. | 1 |
|  | **Engines**:- Classification – thermodynamics, working cycle, fuel system, cylinder orientation; Lubrication System – pump, pressure regulator, lubrication filter, lubrication oil cooler, piston cooling; Governor – speed control mechanism, special type governors; Turbo-charger, battery; Starting Mechanism. | 4 |
|  | **Dragline and Shovel**:- Dragline, crawler-mounted and walking dragline, buckets, boom, power transmission system, walking mechanism, undercarriage unit, working cycle; Construction and classification of shovels; Diesel shovel - power transmission system, crowd and bucket hoist shaft, boom hoist shaft, swing and propel shaft, undercarriage unit, front attachment, torque converter; Electric shovel - deck layout, crowd mechanism, hoist mechanism, swing mechanism, travel mechanism, hydraulic control for dog clutch, pneumatic control system, undercarriage unit and front attachment; Hydraulic Shovel - prime mover, hydraulic mechanism, hydraulic circuit, valve banks, modulator, hydraulic motor and its working principle, undercarriage unit. buckets, dipper-stick, boom; Capacity of shovel | 5 |
|  | **Bucket-Wheel Excavator**:- Construction, components, bucket wheel –cell, semi-cell and cell-less type; Wheel boom and conveyor, transfer conveyor and boom, counter-weight boom, rope-winch and hydraulic system; swing mechanism, wheel drive mechanism, undercarriage unit, travel mechanism, turntable or platform; cutting geometry, terrace cut, dropping cut. | 4 |
|  | **Front-End Loader**:- Classification; components – bucket, arms, transmission system, bucket operation; steering system, braking system, brake shoe assembly; Production capacity | 4 |
|  | **Scraper**:- Classification - self-propelled tractor scraper and towed scraper; different components – bowl, apron, cutting edge; transmission system; control system – hydrauliccontrol, cable control; different operations of scraper. | 3 |
|  | **Off-Highway Truck**:- Classification - rear-dumping, side dumping and bottom dump trucks; Construction – chassis, suspension system, wheels and tires; Cab and body assembly; Power train–transmission with gear box, hydraulic system and with electric drive, allision transmission system; Governor, differential, hydraulic circuit, steering activity, hoisting activity; Air system and circuits. | 5 |
|  | **Dozer**:-Classification and components – blade, arms, undercarriage units, transmission, blade control – cable control dozer, hydraulic system, operation – digging, braking piles; Transporting and spreading - dozer blade capacity, effect of grade, dozer operation. | 4 |
|  | **Grader and Ripper**: - Classification, - self-powered, towed and hydraulically operated grader, Components – blade, power. transmission system, power train with tandem drives and all-wheel drive, mechanically operated grader, blade movement; Brake systems; Ripper, classification, tractor mounted type, shanks, cable control unit, hydraulic control.  | 3 |
|  | **Compacting Equipment**:- Classification, rollers, smooth steel rollers, sheep's foot rollers, pneumatic roller, pad roller, power transmission system, steering system, braking system, three axle tandem roller, other compactors, hand tamper, bares rammer | 3 |
|  | **Drilling Machine**:- Classification, Jack hammer drill, operation, flushing the drill hole, rotation of drill bit, pneumatically operated wagon drill, blast hole drills; drill bit, carset bit, tricone rock roller bit, button bit; Master assembly; Drill rod; feed mechanism, pneumatically operated mechanism, hydraulically operated mechanism, rope pulley mechanism; power transmission system; undercarriage unit; operation. | 4 |
| **TOTAL** | **40** |

## Suggested Readings

1. Burch D. 1997. *Estimating Excavation*. Craftsman Book Company. 446 p.
2. De A. 2014. *Latest Development of Heavy Earth Moving Machinery*. Galgotia Publications Pvt. Ltd. 312 p.
3. Haddock K. 2007. *The Earthmover Encyclopedia*. MotorBooks International.318 p.
4. Martin J. W., Martine T.J., Bennett T.P., and Martin K.M. 1982.*Surface Mining Equipment*. Martin Consultants, Golden, CO. 455 p.
5. Nichols H., Day  D. and Herbert N. 2010. *Moving The Earth: The Workbook of Excavation Sixth Edition / Edition 6*. McGraw-Hill Professional Publishing. 1232 p.
6. Peurifoy R.L., Schexnayder C.J. and Shapira A. 2010.*Construction Planning, Equipment and Methods*. McGraw-Hill Education.800 p.
7. Woodcock C.R. and Mason J.S. 2012. *Bulk Solids Handling:An Introduction to the Practice and Technology*. Springer Science and Business Media. 522 p.

**Code Subject L T S**

**MN3203: Rock Mechanics 3 0 0**

**Full Marks: 100**

## Expected Course Outcome

After going through the course a student may be expected to

* explain the meaning of various physical, mechanical, and elastic properties of rocks,
* calculate the different types of stresses acting on rockand consequent strains,
* assess the mechanism of rock failure in a given stress situation,
* adopt a suitable rock mass classification system for any geo-mining condition,
* determine the in situ stresses in earth’s crust,
* calculate the induced stresses around an excavation,
* understand the basics of subsidence and adopt suitable measure to control subsidence,
* calculate the factor of safety in different slope failure mechanisms,
* calculate the dimensions of pillars left in underground mine for support of incumbent stresses.

## Syllabus

| Sl. No. | Module Name and topics | No. of Classes |
| --- | --- | --- |
| 1 | **Analysis of Stress and Strain on Rock: –** Concept of normal and shear stresses - stresses in two dimension, stress tensor and transformation, Mohr’s circle of stress, stresses; Displacement and strain, infinitesimal strain in two dimensions, Elastic Constants in Rock | 06 |
| 2 | **Physico-Mechanical Properties of Rock: –** Physical properties- density, porosity, permeability, weatherability etc.; Mechanical properties- elastic, non-elastic, dynamic, and time-dependent behavior including strength and deformability | 04 |
| 3 | **Failure in Rocks: –** Mohr-Coulomb, Hoek-Brown, and Griffith’s theory of failure | 03 |
| 4 | **Rock Mass Classification: –** Rock and rock mass, RQD, stand-up time; Terzaghi’s classification, RMR and Q systems | 02 |
| 5 | ***In-situ* Stresses: –** State of stresses in earth’s crust, Anderson’s stress classification; Determination of in situ stresses- flat jack, hydraulic fracturing, and other techniques | 03 |
| 6 | **Induced Stresses and Deformation: –** Induced stresses and deformation around various mine openings- closed form solutions; Numerical solution of induced stresses and deformation | 03 |
| 7 | **Surface Subsidence: –** Basic concepts, fundamental parameters, measurement and prediction; Steps to control subsidence | 03 |
| 8 | **Design of Pillars and Supports: –** Design of coal pillars using different empirical formulations, Calculation of capacity of different underground support systems | 03 |
| 9 | **Stability of Open Pit Slopes**Different modes of instability in open pit mine slopes and calculation of factor of safety | 03 |
|  | **TOTAL** | **30** |

## Suggested Reading

1. Brady B. H. G. 2012. *Rock Mechanics for Underground Mining*. Springer Science & Business Media. 528 p
2. Jaegar J.C., Cook N.G.W. and Zimmerman R.W. 2007*. Fundamentals of Rock Mechanics.* Blackwell Publishing, 488 p
3. Hudson, J.A. and Harrison, J.P. 2000. *Engineering Rock Mechanics - An Introduction to the Principles*. Elsevier. 456 p
4. Read J. and Stacey P. 2009. *Guidelines for Open Pit Slope Design*. CSIRO Publishing, Collingwood, Victoria, Australia. 512p

**Code Subject L T S**

**MN3204: Environmental Engineering of Mines 3 0 0**

**Full Marks: 100**

## Expected Course Outcome

After going through the course a student may be expected to

* explain the principles of sustainable development and environmental sustainability,
* explain the basics of environmental challenges faced by the industrial development,
* ellucidate features of environmental impacts of mining on air, water, land, vegetation etc.,
* apply ecological principles in restoration of mining degraded land and waste dumps,
* devise compliant strategies for environmental management of mines.

## Syllabus

| Sl. No. | Module Name and Topics | No. of Classes |
| --- | --- | --- |
|  | **Environment and Sustainable Development**: – Recent charges in development paradigm;Concepts of Sustainable development;Carrying capacity based development planning | 02 |
|  | **Environmental Impacts of Mining**: – Environment problems caused by mining - influencing factors | 03 |
|  | **Air Pollution**: – Air pollution in mining areas, nature of pollutants size, visibility and health effect; Emission factor and prediction type equation for estimation of dust load from point and nonpoint sources; Sampling and dispersion of air pollutants, atmospheric conditions, acid rain; Air pollution control measures in surface mines. | 05 |
|  | **Noise and Blast Vibrations: –** Sources, propagation, monitoring and control; Blast vibrations including air blasts. Fly rocks from blasting | 03 |
|  | **Water Pollution: –** Aaquatic eco-system, classification of natural waters, toxicity of pollutants,pollutantgroups; Causes of water pollution due to mining, - acid mine/rock drainage, heavy metal pollution,eutrophification,deoxygenation; Monitoring and control of water pollution, ground water monitoring, discharges of mine effluents | 06 |
|  | **Mine Wastes and Disposal: –** Generation, Classification, Characteristics, Sulphide oxidation and control, Acid base accounting, O.B. dumps and amenity banks, tailings managements | 03 |
|  | **Land Reclamation: –** Land reclamation procedure, land use categories pre-mining investigations; Influence of type of deposit, topography and equipment; Top soil removal and storage, characteristics application of mulches; Stabilising agents and fertilizers; Technical and biological reclamation. Afforestation of mined areas, tailing Ponds O.B. dumps and amenity banks; Case examples of mined land reclamation | 03 |
|  | **Environmental Policies and Laws: –** Important national policies and relevant legislations pertaining to environment | 02 |
|  | **Environmental Impact Assessment** and **Environmental Management planning** | 03 |
| **TOTAL** | **30** |

## Suggested Readings

1. Bell F. G. and Donnelly L. J. 2006. *Mining and its Impact on the Environment*. Taylor & Francis. 547p.
2. Canter L. W. 1996. *Environmental Impact Assessment*. McGraw-Hill. 660 p.
3. Chaudhuri A. B.. 1992. *Mine Environment and Management: An Indian Scenario*. APH Publishing. 252 p.
4. Down C. G. and Stocks J. 1977. *Environmental Impact of Mining*. Applied Science Publishers Ltd. 371 p.
5. Eggert R. G. 2013. *Mining and the Environment:International Perspectives on Public Policy*. Routledge. 180 p.
6. Lottermoser B. G. 2003. *Mine Wastes: Characterization, Treatment, and Environmental Impacts*. Springer.277 p.
7. Marcus J. J. 1997. *Mining Environmental Handbook:Effects of Mining on the Environment and American Environmental Controls on Mining*. Imperial College Press. 785 p.
8. Rajaram R. Dutta S. and Parameswaran K. 2005. *Sustainable Mining Practices: A Global Perspective.* Taylor & Francis. 376 p.

**Code Subject L T S**

**MN3205: Mine management legislation and general safety 3 0 0**

**Full Marks: 100**

**Course Outcome:**

After going through the course a student may be expected to

* know about the contributing factors to mine accident and their prevention.
* learn the various provisions of coal mine regulation and their application to mines.
* know the various provisions of mines act 1952 and their implication to mining.
* know the general provisions of miner rules and vocational training rules.

## Syllabus

|  |  |  |
| --- | --- | --- |
| **Sl. No**. | **Module Name and topics** | **No. of Classes** |
| 1. | **A general concept on Mines rules, Regulations, Act, Circulars** | 2 |
| 2. | **Accident and contributing factors** | 2 |
| 3. | **Prevention of accidents and statutory govt bodies to monitoring and implementing safety in mines** | 1 |
| 4. | **Need of safety, safety campaign, SPRS system** | 2 |
| 5. | **Selective provisions on Mines Act 1952** | 3 |
| 6. | **Statutory provisions on CMR** | 7 |
| 7. | **General provisions on Mines Rules 1955** | 2 |
| 8. | **General provisions on VT rules** | 2 |
| 9. | **Relevant DGMS Circulars** | 7 |
| 10. | **ISO and Specific ILO code on safety** | 2 |
| **TOTAL** | **30** |

**Suggested Reading:**

1. Coal Mines Regulations, 2017

2. Mines Act 1952

3. DGMS Circulars – Legislation in Indian mines by Rakesh and Prasad

4. Mines Rules 1955

5. VT rules 1966

6. Golden Book on Mine Legislation by N. C. Dey

7. Safety in coal mines- ILO Geneva

**7th Semester**

**Code Subject L T S**

**MN4101: Mine and Mineral Economics 3 0 0**

**Full Marks: 100**

C**ourse outcome:**

After going through the course a student may be expected to

* will build fundamental concepts of rate of return on mine investment. which will help students to take crucial financial decisions in their future position as manager
* learn the existing laws of the land, taxes and market constraints so that students can understand the social political and market scenario under which a mine operates.
* understanding mineral inventory, mine valuation and feasibility analysis, which in turn will equip the students with relevant knowledge to prepare a feasibility report that can be placed to any potential investor.

**Syllabus**

|  |  |  |
| --- | --- | --- |
| **Sl. No**. | **Module and Topics** | **No. of Hours** |
|  | Minerals and EconomyMine and Mineral Economics,- scope and definitions;Economics of Depleting Resources;Major Issues,- availability, secondary supply, conservation and substitution | 3 |
|  | Mine SamplingTheory of Sampling; Common Methods; Size and Spacing; Sample Preparation; Errors in Sampling; Interpretation of Sampling Results | 4 |
|  | Resource-Reserve DynamicsMineral Resource Classification,- JORC system, UNFC; Estimation of Mineral Inventory | 4 |
|  | Mine Investment AnalysisTime Value of Money,- present and future values, NPV and IRR; Discounted Cash Flow Analysis,- discount factors, risk and uncertainty, inflation adjustments, Feasibility Analysis | 4 |
|  | Mine Finance and AccountingCost of Capital; Sources of Finance; Cost Accounting; Cost-Volume-Profit Analysis, - break-even analysis; Depreciation and Amortization | 4 |
|  | Mine TaxationObjectives and Principles; Mineral Taxation in India and Abroad | 2 |
|  | Mineral Markets and TradeMarket Structure and Analysis; Market Regulatory Organisations; International Mineral Study Group; Mineral Pricing | 4 |
|  | National Mineral PolicyObjectives and Elements; National Mineral Policy of India; Mineral Policies of Some Important Countries; Implementation Strategies | 3 |
|  | Application of Environmental Economics in Mining Industry | 2 |
|  | **TOTAL** | **30** |

**Suggested Reading:**

1. Chatterjee K. K. 2010. Lectures and Thoughts on Mineral Economics. Nova Science Publishers, New York. 254 pages.
2. Darling P (ed.). 2011. SME Mining Engineering Handbook, Third Edition. Two Volume Set. Society for Mining, Metallurgy, and Exploration Inc. Littleton, CO, USA. 1984 pages
3. Deshmukh R. T. 1986. Mineral and Mine Economics. Myra Publications, Nagpur.
4. Gentry D. W. and O’Neil T. J. 1984. Mine Investment Analysis. Society of Mining Engineers of American Institute of Mining, Metallurgical and Petroleum Engineers inc., New York. 502 pages.
5. Runge I. C. 1998. Mining Economics and Strategy. Society for Mining, Metallurgy, and Exploration Inc. Littleton, CO, USA. 316 pages.
6. Barnes, M.P. 1980. Computer Assisted Mineral Appraisal and Feasibility. Society of mining Engineers of American Institute of Mining, Metallurgical and Petroleum Engineers inc., New York.
7. Chatterjee K. K. 1993. An Introduction to Mineral Economics. Wiley Eastern Limited. New Delhi. 353 pages
8. Gocht W., Zantop H. and Eggert R. G. 1988. International Mineral Economics: Mineral Exploration, Mine Valuation, Mineral Markets, International Mineral Policies. Springer. 271 pages
9. Hustrulid [W. A.](http://www.taylorandfrancis.com/books/search/author/william_a_hustrulid/), [Kuchta](http://www.taylorandfrancis.com/books/search/author/mark_kuchta/) M. and [Martin](http://www.taylorandfrancis.com/books/search/author/randall_k_martin/) R. K. 2013. Open Pit Mine Planning and Design, Two Volume Set & CD-ROM Pack, Third Edition. CRC Press. 1500 pages
10. [Martin](http://www.google.co.in/search?tbo=p&tbm=bks&q=inauthor:%22Wade+E.+Martin%22&source=gbs_metadata_r&cad=7) W. E. 1994. Environmental Economics and the Mining Industry, [Volume 4 of studies in risk and uncertainty](http://www.google.co.in/search?tbo=p&tbm=bks&q=bibliogroup:%22Studies+in+risk+and+uncertainty%22&source=gbs_metadata_r&cad=7). Kluwer Academic Publishers, 1994. 130 pages
11. Rudenno V. 2009. The Mining Valuation Handbook: Mining and Energy Valuation for Investors and Management, Third Edition. Wrightbooks, Aus. 448 pages
12. [Stermole](http://www.amazon.com/s/ref%3Dntt_athr_dp_sr_1?_encoding=UTF8&field-author=John%20M.%20Stermole&search-alias=books&sort=relevancerank) J. M. and Stermole F. J. 2012. Economic Evaluations and Investment Decision Methods. 13th Edition. Investment Evaluations Corporation, Golden, Colorado.
13. Tilton J. E. 1992. Mineral Wealth and Economic Development (Resources for the Future) RFF Press, Washington, DC. 130 pages
14. Torries T. F. 1998. Evaluating Mineral Projects: Applications and Misconceptions. Society for Mining, Metallurgy, and Exploration Inc. Littleton, CO, USA. 172 pages.
15. Vogely W. A. 1985. Economics of the Mineral Industries. 4th Revised Sub edition. Society for Mining, Metallurgy, and Exploration Inc. Littleton, CO, USA. 672 pages
16. Wahl, S. von. 1983. Investment Appraisal and Economic Evaluation of Mining Enterprise. Trans Tech Publications. Clausthal-Zellerfeld, FRG. 249 pages

**Code Subject L T S**

**MN4102: Coal and Mineral Beneficiation 3 0 0**

**Full Marks: 100**

**Course Outcome:**

After going through the course a student may be expected to

* explain the fundamental less governing mineral processing for grade up gradation
* explain the basic concepts of size reduction.
* well conversant about the various processes of Mineral Processing.
* know the general Practical.

**Syllabus**

|  |  |  |
| --- | --- | --- |
| **Sl. No**. | **Module Name and topics** | **No. of Classes** |
| 1 | **Comminution**Principles of comminution, Comminution theory, work index | 01 |
| 2 | **Crushers**Basic crushing plant flowsheet, open/closed circuit crushing, Types of crusher, Primary crushers, Secondary crushers | 03 |
| 3 | **Grinding mills**Motion of charge in a tumbling mill, tumbling mills, grinding circuits | 02 |
| 4 | **Particle size analysis and Industrial screening**Sieve analysis, mesh size, Performance of screens,Industrial screen types  | 02 |
| 5 | **Classification**Principles of classification,Hindered and free settling, Types of classifier – Hydraulic, mechanical, hydrocyclone, factors affecting cyclone performance | 03 |
| 6 | **Gravity concentration**Principles of gravity concentration, gravity separators, Jigs, shaking tables | 05 |
| 7 | **Dense medium separation (DMS)**The dense medium, centrifugal separators, DMS circuits, Typical dense medium separations, efficiency of separation, partition curves  | 03 |
| 8 | **Froth flotation**Principles of flotation, classification of minerals, collectors, frothers, Regulators, importance of pH, pulp potential, role of bubble generation and froth performance, modern aspects | 02 |
| 9 | **Magnetic and electrical separation**Magnetic fundamental related to mineral, Magnetic precipitator | 03 |
| 10 | **Dewatering**Thickening, drying, filtration  | 02 |
| 11 | **Coal preparation plant (CPP)**Float and sink analysis, basic layout, main and auxillary equipment. | 02 |
| 12 | **Iron ore beneficiation plant** Primary and secondary ore beneficiation circuits. | 02 |
|  | **TOTAL** | **30** |

### Suggested Readings

1. Arnold B. J. Klima M. S. Bethell P. J. 2007. Designing the Coal Preparation Plant of the Future. Society for Mining, Metallurgy, and Exploration Inc. Littleton, CO, USA. 216 pages
2. Drelich J. 2012. Water in Mineral Processing. Society for Mining, Metallurgy, and Exploration Inc. Littleton, CO, USA. 416p
3. Fuerstenau M. C. and Han K. N. (2003): Principles of Mineral Processing. Society for Mining, Metallurgy, and Exploration Inc. Littleton, CO, USA. 573 pages
4. Gaudin A. M. 1967. Principles of Mineral Dressing McGraw-Hill book Company, Inc. 554 pages.
5. Gupta A. and Yan D (2006): Mineral Processing Design and Operation: An Introduction. Elsevier. 718 pages
6. Hancock B. A., Pon M. R. L. 1999. Mineral Processing: Environment, Health and Safety. The Minerals, Metals & Materials Society (TMS). 448 pages
7. Kawatra S.W. and Natarajan K.A. (eds) 2001. Mineral Biotechnology: Microbial Aspects of Mineral Beneficiation, Metal Extraction, and Environmental Control. Society for Mining, Metallurgy, and Exploration Inc. Littleton, CO, USA. 272 pages.

**Code Subject L T S**

**MN4121/1: Mine safety and ergonomics 3 0 0**

**Full Marks: 100**

**Course Outcome:**

After going through the course a student may be expected to

* apply the acquired knowledge of statutory provisions to improve safety standards' and to minimize accident potential;
* assess the risk magnitude associated with various mining operations;
* apply rudimentary concepts of ergonomics in improving safety and productivity by optimising work-rest schedule of miners;
* use various instruments for recording physiological parameters;
* carry out fatigue assessment of different mining operations.

## Syllabus

|  |  |  |
| --- | --- | --- |
| **Sl. No**. | **Module Name and topics** | **No. of Classes** |
| 1 | **Associated Acts and Rules**Indian Electricity Rules (VIII & X), Land Acquisition Act, Mine Rescue Rules, Workmen's Compensation Act, The Mines Creche Rules, The Maternity Benefit Act, Indian Explosives Act | 06 |
| 2 | **Accident**Classification of accidents Accident statistics, Calculation on accident statistics and finding confidence interval, Accident reports, Risk assessment | 05 |
| 3 | **Concept on Ergonomics and possible application in Mining Operation** | 03 |
| 4 | **Environmental and Physiological parameters and its assessment** | 03 |
| 5 | **Concept and estimation of workload**Workload classification & Physical workload capacity, Ramanthan & Christensen theory- Implications, Aerobic capacity and its effect on worker’s performance, Human factors and energy expenditure related calculationHeart rate measurement and concept on RCC, NCC, RSA | 06 |
| 6 | **Equipment on recording of physiological parameters.**Oxylog, MEIRM, Vibration meter- description and use | 02 |
| 7 | **Assessment of Fatigue and Brouha's Concept, Determination of rest pause period for different mining activities** | 05 |
|  | **TOTAL** | **40** |

### Suggested Readings

1. Astrand P.-O., Rodahl K, Dahl H. A. and Stromme S. B. 2003.Textbook of Work Physiology: Physiological Bases of Exercise. Human Kinetics, 649 pages
2. Bhattacherjee A., Samanta B. and Patra A.K. (Eds). 2012. Safety in Mines—The 34th International Conference of Safety in Mines Research Institutes, New Delhi. Macmillan Publishers India, 860 pages
3. Corlett E. N. and Clark T. S. 2003. The Ergonomics of Workspaces and Machines: A Design Manual. CRC Press. 144 Pages
4. Eastman Kodak Company. 2004. Kodak's Ergonomic Design for People at Work. John Wiley & Sons, 704 pages
5. Slote L. 1987. Hand Book of Occupational Safety and Health. John Wiley & Sons. 744 pages
6. Students will also have to study the relevant portions of

1.The Central Electricity Authority, 2010

2.The Explosives Act, 1884

3.The Maternity Benefit Act 1961

4.The Mines Rescue Rules 1955

5.The Mines Vocational Training Rules, 1966

6.The Mines Crech Rules (DGMS), 1966

7.The Workmen's Compensation Act, 1923

**Code Subject L T S**

**MN4121/2: Rock Slope Engineering 3 0 0**

**Full Marks: 100**

**Course Outcome:**

After going through the course a student may be expected to

* describe the theory behind various mechanisms of instability on rock slopes;
* analyse stability of rock slopes using the limit equilibrium and kinematic methods;
* apply various monitoring and control techniques applicable for stabilization of unstable slopes.

## Syllabus

|  |  |  |
| --- | --- | --- |
| **Sl. No**. | **Module Name and topics** | **No. of Classes** |
| 1 | **Slope Stability as an Engineering Issue**; Slope Failure Causes and Processes; General Modes of Slope Failure in Rock Masses; Mechanical Approaches to Stability analysis | 04 |
| 2 | **Rock Mass Properties:** Engineering Properties of Discontinuities; Shear Strength of Discontinuities; Geologic Data Collection; Hemispherical Projection Techniques | 04 |
| 3 | **Groundwater:** Groundwater Flow Within Rock Masses; Influence of Groundwater on Slope Stability; Evaluation of Groundwater Conditions in Slopes; Slope Dewatering | 04 |
| 4 | **The Rockfall Hazard Rating System**: Overview; Slope Survey and Preliminary Rating; Detailed Rating | 02 |
| 5 | **Kinematic Slope Stability Analysis:** Markland Test for Plane Shear Failure; Markland Test for Toppling Failure; Friction Cone Concept | 02 |
| 6 | **Kinetic Slope Stability Analysis of Planar Failure**: Method of Analysis for Plane Shear Failure; | 02 |
| 7 | **Kinetic Slope Stability Analysis of Toppling Failure**: General Model for Toppling Failure; Limiting Equilibrium Analysis of Toppling on a Stepped Base | 02 |
| 8 | **Kinetic Slope Stability Analysis of Wedge Failure:** Wedge Geometry; Factor-of-Safety Determination; Other Considerations | 02 |
| 9 | **Rock Slope Stabilization Techniques:** Grading; Controlled Blasting (Overbreak Control); Mechanical Stabilization; Structural Stabilization; Vegetative Stabilization; Water Control | 04 |
| 10 | **Geotechnical Instrumentation and Monitoring:** Instrumentation to Measure Rock Deformation; Monitoring | 04 |
|  | **TOTAL** | **30** |

***Suggested Reading:***

1. Hustrulid W. A., McCarter M. K., and Van Zyl D. J. A. *Slope Stability in SurfaceMining.* Society for Mining, Metallurgy, and Exploration, USA. 442 P.
2. Kliche C.A. 1999. *Rock Slope Stability,* Society for Mining, Metallurgy, and Exploration, USA. 253 p.
3. Read J. and Stacey P. 2010. *Guidelines for Open Pit Slope Design.* CRC Press. 496 P.
4. Wyllie D.C. and Mah C.W 2005. *Rock Slope Engineering,* 4111 Edition, CRC Press. 456

**Code Subject L T S**

**MN4121/3: Geographical Information System 3 0 0**

**Full Marks: 100**

**Course Outcome:**

After going through the course a student may be expected to

* describe spatial relationships amongst different objects, area or phenomena;
* analyze spatial data;
* apply techniques of GIS on spatial data related to the field of Geology, Civil Engineering, Mining Engineering and other allied fields;
* carry out complex techniques for solving spatial queries;
* carry out site selection exercises for projects like hydel power stations, dams and barrages, garbage disposal facilities, urban agglomeration development, etc;
* design various civil structures, road networks etc;
* explain relations between different spatial phenomena;
* develop various models to solve any spatial problem or phenomena

**Syllabus**

|  |  |  |
| --- | --- | --- |
| **Sl. No**. | **Module Name and topics** | **No. of Classes** |
| 1 | **Introduction to Geographical Information System (GIS):** Introduction, GIS software's, Hardware requirement, Difference between GIS and other CAD software's. | 01 |
| 2 | **Types of data in GIS**.Data Structure: Attribute structuring, data storage strategies, tabular, hierarchical, relational, network, database organization. | 02 |
| 3 | **Representation:** Raster representation, Vector representation | 01 |
| 4 | **Topology:** Concepts, Rules | 01 |
| 5 | **Geometric structuring:**Vector structuring — spatial relationship, spatial structuring, adjacency, connectivity,Raster structuring — scan orders, quadtrees, range trees, point trees, K-d trees, strip/edge trees. | 02 |
| 6 | **Capture:** Digitizing, digitizing into layers, ScanningEdit: Errors, Accuracy, Precision, Handling errors, Typical digitization errors, Processing of errors, Correcting errors - vector editing, tolerance in editing, raster editing. | 02 |
| 7 | **GIS capabilities:** Measurement, retrieval and classification function,Overlay functions, Neighborhood functions, Connectivity functions. Search: Attribute — SQL select statement, hybrid spatial queries.Geometric — different basic methods of geometric searching, buffer searches, searching quadtree**Conversion:** Rasterization, Focal operations, Filters (low pass and high pass). | 04 |
| 8 | **Manipulation:** Transform, curvilinear transformation**Classification:** User controlled, Automatic Interpolation: Methods for interpolation, trend surface analysis and its significance, spatial prediction using global regression, nearest neighbours, linear interpolators, splines, digital elevation model. | 04 |
| 9 | **Raster Analysis:** terrain analysis, spatial interpolation, distance weighting, triangulated irregular network, isoline threading, Cell based analysis operations | 04 |
| 10 | **Integration:**Vector — and, or, not integration, overlay with attributes, attribute passing, Map logic — Boolean and logical operators,Raster — raster integration, arithmetic operators, overlaying quadtree, vector/raster integration, associated scanned images. | 04 |
|  | **Elements of Internet GIS:** Introduction, WMS, WFS , WCS,**Internet GIS:** Basic components of distributed GIS, Basic component of mobile GIS, Network communication models, Internet protocols, Information exchange process, Static map publishing, Interactive web mapping,**Open GIS:** Open GIS Consortium, Standards, WMS Architecture, WMS specification for graphic element case, WMS specification for data case, WFS Architecture, Setting up a WMS Server, ARC Server. **Distributed GIS:** Basic requirement of Distributed GIS, Distributed web mapping architecture from OGC, Web server, Map server. | 06 |
|  | **TOTAL** | **30** |

**Suggested Reading:**

1. Bossomaier T. and Green D. 2002. *Online GIS and Spatial data.* Taylor and Francis. 222 pages.
2. Burrough P. A., McDonnell R. A., and Lloyd C. D. 2015. *Principles of Geographical Information Systems.* OUP Oxford, 330 pages.
3. Lo C.P. and Yeung A. K.W. 2006. *Concepts and Techniques of Geographic Infbrmation Systems* (2nd Edition). Prentice Hall. 544 pages.
4. Longley P. A., Goodchild M. F., Maguire D. J. and Rhind D.W. 2015. *Geographic Information Science and Systems,* 4th Edition. Wiley. 496 pages.
5. Peng Z. R. and Tsou M.H. 2003. Internet GIS: *Distributed Geographic Information Services for the Internet and Wireless Networks.* Wiley.720 pages.
6. Sekhar S., Xiong H. and Zhou X. 2017. *Encyclopedia of GIS.* Springer. 2507 pages.

**8th Semester**

**Code Subject L T S**

**MN4201: Mine planning and design 3 1 0**

**Full Marks: 100**

**Course Outcome:**

After going through the course a student may be expected to

* know Surpac and Minex mine planning software’s.
* learn the method of planning of coal and metal mines using the software’s.
* to design and optimize coal and metal deposit from exploration data.
* understand the method of modeling blast patterns.

## Syllabus

|  |  |  |
| --- | --- | --- |
| **Sl. No**. | **Module Name and topics** | **No. of Hours** |
| 1. | **Fundamental of Surpac and Minex**  | 06 |
| 2. | **Database (Borehole, Reserve) Creation for Metalliferous and Stratified Deposits** | 06 |
| 3 | **Deposit Modeling for Coal and Metal Deposits** | 06 |
| 4 | **Reserve Estimation for Coal and Metal Deposits** | 06 |
| 5 | **Pit Design and Optimization for Coal and Metal Deposits** | 06 |
| 6 | **Production Scheduling** | 05 |
| 7 | **Drill and Blast Pattern Design** | 05 |
|  | **Total** | **40** |

**Suggested Reading:**

1. Bhattacharya J.(2003): Principles of Mine Planning, 2nd Edition. Allied Publishers Pvt Ltd., New Delhi. 508 pages
2. Darling P (ed.) (2011): SME Mining Engineering Handbook, Third Edition. Two Volume Set. Society for Mining, Metallurgy, and Exploration Inc. Littleton, CO, USA.1984 pages
3. Hustrulid [W. A.](http://www.taylorandfrancis.com/books/search/author/william_a_hustrulid/), [Kuchta](http://www.taylorandfrancis.com/books/search/author/mark_kuchta/) M. and [Martin](http://www.taylorandfrancis.com/books/search/author/randall_k_martin/) R. K. (2013): Open Pit Mine Planning and Design, Two Volume Set & CD-ROM Pack, Third Edition. CRC Press. 1500 pages
4. Mathur S. P. (1993): Mine Planning for Coal. M.G. Consultants, Bilaspur. 295 pages
5. Popov G. and Shiffer V. 2001. The Working of Mineral Deposits. University Press of the Pacific. 620 pages
6. Shevyakov, L. (1965): Mining of Mineral Deposits, Foreign Languages Publishing House, Moscow.
7. Vorobjev B. M. and Desmukh R. T. (1966): Advanced Coal Mining, Two Volume Set, Asia Publishing House, Calcutta.
8. Surpac Manual
9. Minex Manual

**Code Subject L T S**

**MN4202/1: Material handling and transport 3 0 0**

**Full Marks: 100**

**Course Outcome:**

After going through the course a student may be expected to

* explain the underlying principles of Materials Handling
* describe Load Unitization Process and Handling Methods in Bulk Solids Handling;
* classify material handling equipment and state their applicability;
* explain the basic design features of Off-highway Trucks and carry out fleet selection of trucks for openpit mines;
* plan for adoption of safe system of materials handling in mines;

## Syllabus

|  |  |  |
| --- | --- | --- |
| **Sl. No**. | **Module Name and topics** | **No. of Hours** |
| 1. | **Materials Handling:** Definition and Scope; Importance; Systems Concept; Characteristics and Classification of Materials. | 02 |
| 2. | **Principles of Materials Handling:** Principles relating to Planning, Systems, Material Flow, Simplification, Gravity, Space Utilization, Unit Size, Safety, Mechanization, Equipment Selection, Standardization, Flexibility, Dead-Weight, Motion, Idle Time; Maintenance, Obsolescence, Control, Capacity, and Performance. | 04 |
| 3 | **Unit Load Concept:** Definition; Advantages and Disadvantages LoadUnitization Process and Handling Methods;Pallets, Skids and Containers; Alternative Methods of Handling | 04 |
| 4 | **Classification of Materials Handling Equipment**: Basic Equipment Types; Classification of Handling Equipment | 02 |
| 5 | **Off-Highway Trucks:** General Applicability; Descriptions, Drive Components, Brakes, Tyres, Dump Bodies, Specifications, Special Equipment;Performance: Horsepower Utilization, Retarding, Gradeability, Trolley Assist, Automatic Truck Control; Truck Cycle Time; - Spot and Load, Travel, Turn and Dump, Wait, Delays, Total Cycle Time; Production and Fleet Requirements, - Matching Trucks and Loading Equipment,Availability and Utilization, Production, Truck Requirements | 6 |
| 6 | **Conveyors:** Belt Conveyors; Chain Conveyors; Haulage Conveyors; Cable Conveyors; Bucket Conveyors;Roller Conveyors; Screw Conveyors; Pneumatic Conveyors;Design and Selection of Conveyor-Belt. | 04 |
| 7 | **Hoisting Equipment**: Parts of Hoisting Equipment; Hoists, Winches, Elevators, Cranes, Derricks | 02 |
| 8 | **Bulk Handling Equipment and Systems:** Storage of Bulk Solids; Bulk Handling Equipment | 02 |
| 9 | **Auxiliary Equipment:** Gates, Feeders, Chutes, Positioners, Ball Tables, Weighing and Control Equipment, Pallet Loader and Unloader | 02 |
| 10 | **Organisation, Maintenance and Safety:** Organisation, Maintenance, Safety in Materials Handling | 02 |
|  | **Total** | **30** |

**Suggested Reading:**

1. Arora K. C. and Shinde V. V. 2007. Aspects of Materials Handling. Firewall Media. 327 pages
2. Conveyor Equipment Manufacturers Association. 2007. Belt Conveyors for Bulk Materials. Conveyor Equipment Manufacturers Association. 600 pages
3. Mulcahy D. E. 1999. Materials Handling Handbook. McGraw-Hill, 768 pages
4. Ray T. K. 2005. Mechanical Handling of Materials. Asian Books Private Limited. 245 pages
5. Wolhbier R. 1-1. (ed). 1986. Hydraulic Conveying and Slurry Pipeline Technology. Trans. Tech Publication. 232 pages
6. Woodcock C. R. and Mason J. S. 2013. Bulk Solids Handling: An Introduction to the Practice and li,chnologv, Springer Science & Business Media. 522 pages

**Code Subject L T S**

**MN4202/2: Remote sensing and image processing 3 0 0**

**Full Marks: 100**

**Course Outcome:**

After going through the course a student may be expected to

* describe spatial relationships amongst different objects, area or phenomena;
* analyze aerial photographs and satellite imageries;
* apply image processing techniques to extract information related to earth's surface;
* carry out complex geotechnical analyses for solving spatial queries
* plan for a site of hydel power projects, dam location, garbage disposal, new urban agglomeration development, evacuation process to combat natural hazards and various kinds of site selection
* explain relations between different spatial phenomena;
* develop rudimentary models to solve various spatial problems or phenomena;

## Syllabus

|  |  |  |
| --- | --- | --- |
| **Sl. No**. | **Module Name and topics** | **No. of Hours** |
| 1. | **Concepts of remote sensing:** Introduction, Energy sources and radiation principles, Energy interaction in the atmosphere, Energy interactions with earth surface features, Data acquisition and interpretation | 01 |
| 2. | **Elements of photographic system:**  Basic negative to positive photographic sequence, Processing black and white films, Simple camera. | 01 |
| 3 | **Films Filters and its application in aerial photography:** Spectral sensitivity of black and white films, Red green blue system, Cubic representation - additive system, subtractive system, Colour films, Processing colour films, Colour infrared films, Filters, aerial cameras, Types of aerial photographs, Scale of aerial photographs, Ground coverage of aerial photographs, Photographic resolution. | 03 |
| 4 | **Photogrammetry:**  Introduction, Geometric elements of a vertical photograph, Determining horizontal ground lengths, Directions and angles from photocoordinates, Relief displacement of vertical features, Image parallax, Parallax measurement, Ground control for aerial photography, Use of ground control in determining the flying height and airbase of aerial photographs, Orthophotos, Flight planning | 03 |
| 5 | **Introduction to air photo interpretation:** Fundamentals of air photo interpretation, Basic air photo interpretation equipment, Interpretation for application to: Geology, Landuse, Forestry, Water Resource and environment | 03 |
| 6 | **Physical basis of Satellite Remote Sensing:** Thermal infrared remote sensing, Microwave remote sensing, Hyperspectral remote sensing. | 04 |
| 7 | **Sensors and Platforms:**  Evolution of sensors, Sensor – radiation receiving systems, spectral bands, airborne systems, Platforms - orbits, SPOT system, Other systems - Meteosat, NOAA, Thermal sensor systems, LANDSAT, ERS-I and 2, RADARSAT, JERS, IKONOS. | 02 |
| 8 | **Visual interpretation of images:** Interpretation procedure, Identification of thematic objects. | 01 |
| 9 | **Preliminary processing:** Digital image data formats, transformation of digital numbers, Digital image preprocessing- Radiometric errors and their correction: Line dropout, Line stripping; Atmospheric errors and their correction: Haze, Skylight, Sun angle errors and their corrections. Geometric errors their correction — types, image offset error; correction - spatial interpolation: GCPs, co-ordinate transformation, Mathematical transformations, RMS;Intensity interpolation: Resampling techniques— Nearest Neighbourhood, Bilinear interpolation, cubic convolution. Image enhancements: types, Contrast enhancement: Linear and nonlinear contrast stretch. Spatial enhancement: Spatial frequency, filters — low pass and high pass filters.Image Rationing, Principal component analysis, Tasselled cap transformation. | 04 |
| 10 | **Unsupervised classification:**  Ascendant hierarchical classification, Classification by K-means- principles, method of interpretation, comparison with ascendant hierarchic classification, Hybrid classifier, Texture based classification. | 03 |
| 11 | **Supervised classification:** Training set data, Minimum distance to mean classification, Parallelepiped classification, Maximum likelihood classification - principle of classification, rejection threshold, iterations. | 03 |
| 12 | **Quality of interpretation:** Geometric accuracy: precision of position, precision of shape, reliability, Semantic accuracy - definition, establishment of typology. establishment of error matrix, Limitations of conventional methods of accuracy assessment | **02** |
|  | **Total** | **30** |

**Suggested Reading:**

1. Jenson J.R. 2007. *Introductory Digital Image Processing.* 3rd edition. 379 pages
2. Bhatia S.C.2008. *Fundamentals of Remote Sensing.* Atlantic Publishers and Distributors Limited, New Delhi.535 pages.
3. Lillesand T.M., Kaiefer R.W. and Chipman J. 2015.  *Remote Sensing and Image* *Interpretation,* 7th Edition. Wiley. 768 pages
4. Sabins F.F. 2007. *Remote Sensing Principles and Interpretation.* Waveland Press. 494 pages
5. Emery W. And Camps Camps A. 2017. *Introduction to Satellite Remote Sensing.* Elsevier. 856 pages
6. Gao J. 2009. *Digital Analysis of Remotely Sensed Imagery.* McGraw Hill Professional. 674 pages.
7. Campbel J.B. and Wynne R.H. 2013. *Introduction to Remote Sensing.* Wiley. 683 pages.

**Code Subject L T S**

**MN4202/3: Environmental impact assessment and management of mining project 3 0 0**

**Full Marks: 100**

**Course Outcome:**

After going through the course a student may be expected to

* explain the command and control setup for environmental Management of mining operations in India
* explain the basic principles of EIA
* develop schemes for carrying out EIA of mining projects
* evaluate project alternatives from environmental view point
* explain the concept of Total Quality Management
* explain the basic principles of EMS based on ISO 14001
* carry our preliminary design and implementation scheme for environmental managementof simple projects.

## Syllabus

|  |  |  |
| --- | --- | --- |
| **Sl. No**. | **Module Name and topics** | **No. of Hours** |
| 1. | **Environmental Legislation:**Environmental concerns in India, Policy and legal aspects of Environmental Management, Environmental Policies, Environmental Laws and Regulations;Environmental Clearance procedure in India | 06 |
| 2. | **Environmental Impact Assessment** (HA):Regulatory Provision of EIA in India;EIA Process, - screening, scoping and baseline studies, impact prediction and analysis, mitigation planning, monitoring and surveillance;EIA Methodologies, - simple methods for impact identification-matrices, networks, and checklists;Description of environmental setting (affected environment); Prediction and assessment of impacts on the socioeconomic environment; Decision methods for evaluation of alternatives;Documentation of EIA and EMP | 12 |
| 3 | **Environmental** **Management** **System** **(EMS):**Concepts of 'quality assurance' and 'total quality management'; General approach, - requirements of ISO 14001, Other ISO 14000 standards, Engineering aspects of ISO 14001 requirements; Design and Implementation of ISO 14001; Measurement Systems in Environmental Management, Measurement SystemErrors;Quantification and Effects of various types of Pollution, - Air pollution, Water Pollution, Control of Air and Water Pollution, Noise, Vibration and ShockPollution, Waste Management System Reliability and Risk Assessment for Environmental Protection | 12 |
|  | **Total** | **30** |

#### Suggested Reading:

1. Anon. 2003. *Best Management Practices Manual for Environmental Management of Mining Project.*  Vol. I & II. 2003. Ministry of Environment and Forest, GOI. 308 pages.
2. Canter L. W. 1996. Environmental Impact Assessment (2nd ed), McGraw Hill Inc. 660 pages
3. Chernaik M. 2010. *Guidebook for Evaluating Mining Project EIAs.* Environmental Law Alliance Worldwide, U.S.A. 122 pages
4. Dahlgaard J. J., Kristensen K. and Kanji G. K. *Fundamentals of Total Quality Management: Process Analysis and Improvement.* Taylor and Francis. 358 pages.
5. Gilpin A. 1995. *Environmental Impact Assessment: Cutting Edge for the 21st Century.* Cambridge University Press. 182 pages
6. Glasson J., Therivel R. and Chadwick A. 2013. *Introduction to Environmental Impact Assessment.* Routledge, 448 pages
7. Mercus J. J. 1997. *Mining Environmental Handbook: Effects of Mining on the Environment and American Environmental Controls on Mining.* Imperial College Press, London. 815 pages
8. Morris A. S. 2004. ISO 14000 *Environmental Management Standards: Engineering and Financial* *Aspects.* John Wiley & Sons. 302 pages.
9. Morris P. and Therivel R. 2009. *Methods of Environmental Impact Assessment.* Routledge. 576 pages
10. Sinha I. N. 2000. *A Framework of EIA for Environmental Sustainability.* ENVIS Monograph. Indian School of Mines, Dhanbad. 173 pages
11. Wathern P. 1988. *Environmental Impact Assessment-Theory and Practice.* Unwin Hynman, Sydney.
12. Younger, P. L., Banwart, S. A. and Hedin, R. S. 2002.  *Mine Water: Hydrology, Pollution, Remediation.* Kluwer Academic Publishers, London. 442 pages

*DUAL DEGREE IN MINING ENGINEERING*

**Seventh Semester (DD)**

**Code Subject L T S**

**MN4122: Mine system analysis and design 3 0 0**

**Full Marks: 100**

**Course Outcome:**

After going through the course a student may be expected to

* know the concepts of system
* know in details the mining method selection procedure
* know about planning of infrastructure
* get a glimpse of management and administration of mines.

## Syllabus

|  |  |  |
| --- | --- | --- |
| **Sl. No**. | **Module Name and topics** | **No. of Hours** |
| 1. | **Systems Concept**, Systems approach to mine planning and Design. Underground Mine Planning | 02 |
| 2. | **Mining Method Selection:** Evaluation of Mining Methods and Systems; Mining Methods Classification System; Selection Process for Hard-Rock Mining; Selection Process for Underground Soft-Rock Mining; Comparison of Underground Mining Methods; Comparison of Surface Mining Methods | 04 |
| 3 | **Planning Infrastructure and Services**: Electric Power Distribution and Utilization; Compressed Air; Mine Communications, Monitoring, and Control; Dewatering Surface Operations; Dewatering Underground Operations; Physical Asset Management; Automation and Robotics; Mine Infrastructure Maintenance; Systems Engineering | 06 |
| 4 | **Development Planning for Underground Mines:** Hard-Rock Equipment Selection and Sizing; Soft-Rock Equipment Selection and Sizing; Underground Horizontal and Inclined Development Methods ; Subsurface Mine Development; Construction of Underground Openings and Related Infrastructure; Underground Ore Movement; Hoisting Systems. | 06 |
| 5 | **Management and Administration:** Mine Economics, Management, and Law; Economic Principles for Decision Making; Management, Employee Relations, and Training. | 06 |
| 6 | **Environmental Issues:** Site Environmental Considerations; Mining and Sustainability; Waste Disposal and Contamination Management,- tailings impoundments and dams, waste piles and dumps; Closure Planning; Community and Social Issues; Social License to Operate; Cultural Considerations for Mining and Indigenous Communities; Management of the Social Impacts of Mining | 06 |
|  | **Total** | **30** |

#### Suggested Reading:

1. Bhattacharya J.(2003): Principles of Mine Planning, 2nd Edition. Allied Publishers Pvt Ltd., New Delhi. 508 pages
2. Darling P (ed.) (2011): SME Mining Engineering Handbook, Third Edition. Two Volume Set. Society for Mining, Metallurgy, and Exploration Inc. Littleton, CO, USA.1984 pages
3. Hustrulid [W. A.](http://www.taylorandfrancis.com/books/search/author/william_a_hustrulid/), [Kuchta](http://www.taylorandfrancis.com/books/search/author/mark_kuchta/) M. and [Martin](http://www.taylorandfrancis.com/books/search/author/randall_k_martin/) R. K. (2013): Open Pit Mine Planning and Design, Two Volume Set & CD-ROM Pack, Third Edition. CRC Press. 1308 pages
4. Mathur S. P. (1993): Mine Planning for Coal. M.G. Consultants, Bilaspur. 295 pages
5. Popov G. and Shiffer V. 2001. The Working of Mineral Deposits. University Press of the Pacific. 620 pages
6. Shevyakov, L. (1965): Mining of Mineral Deposits, Foreign Languages Publishing House, Moscow.
7. Vorobjev B. M. and Desmukh R. T. (1966): Advanced Coal Mining, Two Volume Set, Asia Publishing House, Calcutta.

**Eighth semester (DD)**

**Code Subject L T S**

**MN4203: Project Management 3 0 0**

**Full Marks: 100**

**Course Outcome:**

After going through the course a student may be expected to

* know the concepts of project planning
* will be able to learn cost estimation procedure and budgeting techniques
* know about the information system in projects
* know about controlling a project

## Syllabus

|  |  |  |
| --- | --- | --- |
| **Sl. No**. | **Module Name and topics** | **No. of Hours** |
| 1. | **Philosophy and concepts:** Project, Management Needs, Goals; Functions and Viewpoints of Management, Evolution of Project Management; Different Forms of Project Management; Project Management in Industrial Settings and in the Service Sector  | 04 |
| 2. | **Project planning:** Planning Fundamentals, Planning Steps, Project Master Plan, Scope and Work Definition, Project Organization Structure and Responsibilities, Project Management System, Scheduling, Planning and Scheduling Charts; Network Scheduling and PDM, Logic Diagrams and Networks, The Critical Path, Calendar Scheduling and Time-Based Networks, Management Schedule Reserve, PDM Networks, PERT, CPM, Resource Allocation, and GERT  | 04 |
| 3 | **Cost estimating and budgeting:** Elements of Budgets and Estimates, Project Cost Accounting and Management Information Systems, Budgeting Using Cost Accounts, Cost Summaries, Cost Schedules and Forecasts. | 04 |
| 4 | **Managing risks in projects**: Risk Concepts, Risk Identification, Risk Assessment, Risk Response Planning. Risk Analysis Methods  | 04 |
| 5 | **Project control**: The Control Process: Information Monitoring, Internal and External Project Control, Traditional Cost Control, Cost Accounting Systems for Project Control, Project Control Process, Project Control Emphasis, Performance Analysis, Forecasting “To Complete” and “At Completion”, Performance Index Monitoring, Variance Limits, Controlling Changes, Contract Administration. | 04 |
| 6 | **Project management information systems:** Functions of the PMIS, Computer-Based Tools, Computer-Based PMI Systems, Representative Computer-Based PMISs, Web-Based Project Management, Applying Computer-Based Project Management Systems | 04 |
| 7 | **Project evaluation, reporting, and termination**: Project Evaluation, Project Review Meetings, Reporting, Terminating the Project; -Termination Responsibilities, Closing the Contract, Project Extensions, Project Summary | 02 |
| 8 | **Project roles, responsibility, and authority:** The Project Manager, Project Management Authority, Selecting the Project Manager, Ways of Filling the Project Management Role, Roles in the Project Team, Roles Outside the Project Team, Relationships Among Project and Functional Roles  | 02 |
| 9 | **Project failure, success, and lessons learned:** Project Failure, Project Management Causes of Project Failure, Project Success, Project Management Causes of Project Success, A Model and Procedure for Analyzing Project Performance | 02 |
|  | **Total** | **30** |

#### Suggested Reading:

1. Heagney J. 2012. *Fundamentals of Project Management*, Fourth Edition. American Management Association. 202 pages.
2. Lester A. 2013. *Project Management, Planning and Control: Managing Engineering, Construction and Manufacturing Projects to PMI, APM and BSI Standards. Butterworth-Heinemann*, 592 pages
3. Meredith J.R. and Mantel S.J., 2005. *Project Management: a Managerial Approach*. John Wiley, 666 pages
4. NicholasJ.M. 2004. *Project Management for Business and Engineering:* Principles and Practice, 2ND EDITION. Elsevier Butterworth–Heinemann. 603 pages.
5. Nicholas J.M. and Steyn H. 2012. *Project Management for Engineering, Business and Technology,*FOURTH EDITION. Routledge. 675 pages
6. Smith N.G. 2002. *Engineering Project Management*. 2nd Edition. Blackwell Science. 382 pages.
7. Twort A. C. and Rees J. G. 2011 *Civil Engineering Project Management*, Fourth Edition. Elsevier. 263 pages
8. Young T.L. 2013. *Successful Project Management*. Kogan Page Publishers. 232 pages

**Code Subject L T S**

**MN4204: Ergonomics 3 0 0**

**Full Marks: 100**

**Course Outcome:**

After going through the course a student may be expected to

* know about achieving better comfort level during stretch of work in shift
* know about rationalizing of work-rest bouts in workplace
* know to optimise work environment

**Syllabus**

|  |  |  |
| --- | --- | --- |
| **Sl. No**. | **Module Name and topics** | **No. of Hours** |
| 1. | **Ergonomics** – Objectives and Needs Over view on Ergonomic principles and possible application to face challenges in industriesPosture and MovementApplication of Softwares for posture analysis | 04 |
| 2. | **Industrial Ergonomics and Application Standards**  Work load classificationPhysiological parameters (direct and derived)Environmental parameters (direct and derived)Relevant calculations on work-rest scheduling Ergonomics principles for work place design | 05 |
| 3 | **Determination of stressor factors and its effect**  Heat stress factors and indexThermal comfort factors Psycho physiological factorsMuscle fatigue factorsConcept of fatigue sustainability and LCW  | 05 |
| 4 | **Human factors and ergonomics issue in industries** Human factor issues in machine design Analysis of human factor issues Machine design, ergonomics in operational biomechanics Concept of body somatotyping and anthropometry Consideration of anthropometry in machine design Human factors guidelines and safety  | 06 |
| 5 | **OPERATIONAL POSTURE AND BIOMECHANICS**  Work stress due to awkward posture Muscle fatigue Effect of machine vibration Design to reduce force exertion Musculoskeletal disorders and machine operation | 05 |
| 6 | **Ergonomic guidelines for work station design**  Occupational and Non-occupational risk factorsWork related musculo skeletal disorders (WMSD)CTD and prevention of CTD by engineering applicationApplication of Software's Case studies  | 05 |
|  | **Total** | **30** |

#### Suggested Reading:

1. Introduction to Ergonomics (Instructors Manual) by RS Bridger
2. Text Book of Work Physiology by Astrand And Rodahl
3. Biomechanica in Ergonomics by Shrawan Kumar
4. The Ergonomics of Workspaces and Machines by Corlett and Clark

**Ninth Semester (DD)**

**Code Subject L T S**

**MN4204: Subsurface rock engineering and tunnelling 3 0 0**

**Full Marks: 100**

**Course Outcome:**

After going through the course a student may be expected to

* know to evaluate rock mass strength
* know the various methods of tunnelling
* know about instrumentation in tunnelling

**Syllabus**

|  |  |  |
| --- | --- | --- |
| **Sl. No**. | **Module Name and topics** | **No. of Hours** |
| 1. | **Rock mass strength**: Evaluation of rock mass strength for Rock Engineering  | 04 |
| 2. | **Tunnelling methods**. Geo-hydrological hazards in tunnelling. | 04 |
| 3 | **Tunnelling ground classification**: grounds with residual stresses, squeezing ground, swelling ground, ralveling ground, running ground conditions and methods in controlling such grounds, Terrain evaluation and site characterization for tunnels in rocks.  | 04 |
| 4 | **Geotechnical problems associated with tunnels**: stand-up time, bridging capacity of rocks, over-breaks, arching action.  | 04 |
| 5 | **Stability of tunnels:** Rock quality classification methods for evaluation of support requirements: rock bolting, shotcreting, rib-support and flexible support  | 04 |
| 6 | **Tunnelling in weak rocks.**  | 04 |
| 7 | **Tunnelling instrumentation, in situ stress measurement tests.**  | 04 |
| 8 | **Case studies in rock engineering and tunnelling** | 04 |
|  | **Total** | **30** |

**Suggested Reading:**

1. Brady B.H.G. and Brown E.T. Rock Mechanics for Underground Mining
2. Hudson J.A. and Harrison J.P. Engineering Rock Mechanics- An Introduction to Principles.
3. Pariseau W. G. 2011. Design Analysis in Rock Mechanics, Second Edition. CRC Press. 698 pages
4. Palmstrom A. and Stille H. 2015. Rock engineering, 2nd edition. ICE Publishing, 444 pages.
5. Wood A. M. 2000. Tunnelling: Management by Design. CRC Press. 328 pages