

# Mining and mineral processing engineering syllabus

## Mining and mineral processing engineering examinations

### Group A - Compulsory examinations (six required)

#### 24-MMP-A1 General Geology and Exploration

Mineralogy, determination and identification of minerals, with emphasis on ore minerals, Structures and forms of orebodies; processes for the formation of ores; classification of ores; definition of reserves and resources Petrology. Structural geology. Internal and external geologic processes. Structure and strategy of exploration programs, exploration geochemistry, devising drilling/trenching programs, surveying techniques and remote sensing.

*Textbooks (most recent edition is recommended):*

- Kehew, A. E., General Geology for Engineers, Prentice Hall Canada Inc.
- Reynolds, S. and Johnson J., Exploring Geology, McGraw Hill.
- Moon, C.J. et al, Introduction to Mineral Exploration, Blackwell.

#### 24-MMP-A2 Underground Mining Methods and Design

Description and usage of the following underground mining methods: room and pillar, long-hole, longwall, open stoping, shrinkage, cut and fill sub-level stoping, timbered stoping, top slicing, underhand and overhand stoping, block caving, sublevel caving, and vertical crater retreat. Requirements for development and services including: shafts, hoists, ramp and multi-level access design. Design of pumping, ventilation, compressed air and power facilities. Underground design including: stope development, haulage systems, backfill, equipment selection, and scheduling of development and operations. Capital and operating cost estimation associated with underground mining activities.

*Textbooks (most recent edition is recommended):*

- Hartman, H. L., Introductory Mining Engineering, J. Wiley.
- Hustrulid, W.A. and Richard L. Bullock (ed.), Underground Mining Methods: Engineering Fundamentals and International Case Studies, SME Littleton.
- Darling, P. (Editor), SME Mining Engineering Handbook, Vol I & II, SME Littleton.
- Mular, A.L. & R. Poulin, CAPCOSTS- A Handbook for Estimating Mining and Mineral Processing Equipment Costs and Capital Expenditures and Aiding Mineral Project Evaluations, Special Volume 47, CIM, Montréal, 1998, 319 p.

#### 24-MMP-A3 Mineral Processing

Material balances. Measures of efficiency of mineral separations. Sampling systems and sampling errors, use of Gy's equation. Particle size measurement and presentation of results. Mineral liberation by crushing, grinding, screening, and classification. Mineral concentration using gravity, dense medium, magnetic and high-tension separators. Froth flotation and flotation circuits. Use of reagents — collectors, frothers, depressants, and activators. Dewatering techniques — thickening, filtering, drying, flocculants, and filter aids. Flowsheet analysis emphasizing Canadian mineral processing plants.

*Textbooks (most recent edition is recommended):*

- Wills, Barry and James A. Finch, Mineral Processing Technology, Butterworth Heinmann.
- Darling, P. (Editor), SME Mining Engineering Handbook, Vol I & II, SME Littleton.

## 24-MMP-A4 Mine Valuation and Mineral Resource Estimation

Aspects of geological conditions and control relating to mineral resource estimation. Principles of mineral resource estimation using conventional and geostatistical methods. Aspects of mine valuation - assessment of market conditions, capital and operating cost estimation, estimation of revenue including smelter contracts, taxation, cash flow, sensitivity and risk analyses, and economic optimisation of mine development and extraction variables including cut-off grade, installed capacity utilisation and sequencing.

*Textbooks (most recent edition is recommended):*

- Runge, I.C., Mining Economics and Strategy, SME Littleton.
- Gocht, W.R., H. Zantop and R. G. Eggert, International Mineral Economics, Springer-Verlag.
- Vogely, W.A. (Editor), Economics of the Mineral Industries, SME Littleton.

## 24-MMP-A5 Surface Mining Methods and Design

Cyclic and continuous surface mining methods including strip mining, open pit mining, (dragline, bucketwheel excavators, truck and shovel and dozer methods), hydraulic mining and dredging. Design criteria for surface mines including scheduling, material removal and capacity-rated equipment-sizing, availability and utilization calculations, slope design, stripping ratio, materials handling, pit ramp and waste dump design, pit dewatering and land reclamation. Capital and operating cost estimation associated with surface mining activities.

*Textbooks (most recent edition is recommended):*

- Kennedy, B.A. (Editor), Surface Mining, SME Littleton.
- Hartman, H. L., Introductory Mining Engineering, J. Wiley.

## 24-MMP-A6 Mining and the Environment

Overall understanding of environmental practices in mining including; waste rock and tailings disposal systems; prediction/prevention/treatment/control of acid rock drainage; control of dust/noise/gaseous emissions; environmental impact assessment (EIA) processes; environmental effects monitoring (surface water and groundwater); reclamation and decommissioning; government regulations relating to environmental protection in design/operation/closure of mines; sustainable development principles and application to mining; risk assessment and management principles with respect to the environment.

*Textbooks (most recent edition is recommended):*

- Bell, Fred and Laurence Donnelly, Mining and its Impact on the Environment, Routledge.
- Lottermoser, Bernd G., Mine Wastes: Characterization, Treatment and Environmental Impacts, Springer.
- Aubertin, M., Busière, B. et Bernie, L., Environnement et gestion des rejets miniers, Presses internationale.

## Group B - Optional examinations (three required)

### 24-MMP-B1 Applied Rock Mechanics

In situ and laboratory determination of rock properties. Subsurface investigations, structural surveys and rock mass classification systems. In situ stress determination in rock masses. Evaluation of stress fields around mine openings using analytical, empirical and numerical methods. Underground rock support systems. Mine subsidence. Hydraulic backfill, earth pressures, consolidation theory and practical consequences in mining. Field instrumentation, monitoring and control techniques, including seismic events, groundwater.

*Textbooks (most recent edition is recommended):*

- Hoek, E. and Brown, E.T., Underground Excavations in Rock, Institution of Mining and Metallurgy, London, 1981.
- Darling, P. (Editor), SME Mining Engineering Handbook, Vol I & II, 3rd edition, SME Littleton, CO., 2011, 1984 p.
- Brady, B.H.E. and Brown, Rock Mechanics for Underground Mining, 2nd edition, E.T. George Allen and Unwin, London, 1993.

## 24-MMP-B2 Rock Fragmentation

Principles and technologies of cutting, drilling, boring, and blasting, including vibration and shock effects. Explosives, including properties and classification, selection of chemical explosives and explosive mixtures, regulations and approved procedures for handling, storing, loading, and detonating. Blasting design, including detonators, delay systems, control blasting methods. Vibrations monitoring and blasting methods for vibrations control.

*Textbooks (most recent edition is recommended):*

- Hustrulid, W., Blasting Principles for Open Pit Mining, Volume 1, General Design Concepts, and Volume 2, Theoretical Foundations, A.A. Balkema.
- Persson, P.A., R. Holmberg, and J. Lee, Rock Blasting and Explosives Engineering, Routledge.
- Darling, P., SME Mining Engineering Handbook, Vol I & II, SME Littleton.

## 24-MMP-B3 Material Handling

Classification of materials handling systems. Mining systems. Equipment selection criteria. Earthmoving fundamentals. Loading and haulage equipment. Belt conveyors. Rail haulage. Mine hoisting systems. Slurry transport. Technical and economic considerations.

*Textbooks (most recent edition is recommended):*

- Das, B.M., Principles of Geotechnical Engineering, Cengage.
- Darling, P. (Editor), SME Mining Engineering Handbook, Vol I & II, SME Littleton.

## 24-MMP-B4 Mine ventilation and occupational hygiene

Mine ventilation requirements, engineering principles, and design criteria for underground mines, air flow through mine openings, air quality and control. Statutory regulations. Mine ventilation risk assessment and mitigation strategies. Control and detection of hazards in surface and underground mines: rock falls, slope failures, radiation, heat, noise, dust and gas. Safety practices and equipment employed.

*Textbooks (most recent edition is recommended):*

- Hartman, H.L., and others, Mine Ventilation and Air Conditioning, John Wiley and Sons Inc.
- McPherson, M.J., Subsurface Ventilation & Environmental Engineering, Chapman & Hall.
- Darling, P. (Editor), SME Mining Engineering Handbook, Vol I & II, SME Littleton.

## 24-MMP-B5 Mineral Processing Design and Operations

Mineral processing flowsheet synthesis and circuit design. Material and energy balances. Selection and sizing of mineral processing equipment: comminution, classification, gravity, magnetic and electrostatic separations, froth flotation, dewatering, solids and slurry storage and transport. Sampling, data logging, process modelling and simulation of mineral process plants. Capital and operating cost estimations. Economic analysis.

*Textbooks (most recent edition is recommended):*

- Mular, A.L., D.N. Halbe, and D.J. Barratt, Mineral Processing Plant Design, Practice and Control. Volumes 1 and 2, SME Littleton.
- A.L. Mular & R. Poulin, CAPCOSTS - A Handbook for Estimating Mining and Mineral Processing Equipment

## 24-MMP-B6 Mill Process Control

Basic process control and analysis: PID (Proportional-Integral-Derivative) loops, feedback, feed forward, cascade, interacting control systems, data acquisition, control loop monitoring and control network technology (fieldbus, wireless, security). Controller settings — analytical and loop-tuning techniques. Computer control modelling, on stream analysis, sampling for control strategies for all of the mineral processing units including benefits and justification of automatic and AI control systems. Instrumentation for bin and sump level sensing, solids and slurry flow rates, pulp density, power draw, reagent addition, pH measurement. Alarm and interlock systems, sequencing problems. Benefits and justification of automatic control.

*Textbooks (most recent edition is recommended):*

- Seborg, D.E., T.F. Edgar, D.A. Mellichamp and Francis J. Doyle III, Process Dynamics and Control, 4th Edition, Wiley, 2016, 512 p. ISBN: 978-1-119-28591-5.
- Considine, D.M. (ed), Process Instruments and Controls Handbook, 5th edition, McGraw-Hill, New York, 1999.
- P.G. Claridge (ed.), Operation and Maintenance in Mineral Processing Plants, CIM, Vol.40, 1989, Section 9.

## 24-MMP-B6 Extractive Metallurgy

Thermodynamics of pyro- and hydro-metallurgical extraction processes. Kinetics of extraction processes. Materials preparation in the metallurgical industry. Slag and mattes. Pyrometallurgical processes including calcining, roasting, and smelting. Hydrometallurgical processes, including leaching (autoclave, agitation, and heap), purification and concentration via ion exchange, and solvent extraction, metal recovery via electrowinning, electrolysis or precipitation. Refining processes. Flowsheet studies.

*Textbooks (most recent edition is recommended):*

- Rosenqvist, T., Principles of Extractive Metallurgy, Tapir Academic Press.
- C. Bodsworth, The Extraction and Refining of Metals, CRC Press.
- Moore, J. J., Chemical Metallurgy, Butterworth-Heinemann.

## 24-MMP-B7 Mine Management and Systems Analysis

Mine organization and management. Budgeting and management accounting. Work design and scheduling, work study and sampling, development of standard practices. Organizational structure of business in the mining industry. Contracting procedures. Labour/management relations. Operations Research methods: graph theory (shortest path, minimum-cost flow, maximum flow CPM, PERT), linear, integer and nonlinear programming. Design of experiments.

*Textbooks (most recent edition is recommended):*

- Darling, P. (Editor), SME Mining Engineering Handbook, Vol I & II, SME Littleton.
- Hillier, F. and Lieberman G., Introduction to Operations Research, McGraw Hill.
- Stevenson, W.J., Mottaghi, H. and Bakhtiari, B., Operations Management, McGraw Hill.

## 24-MMP-B8 Rock Slope Engineering

Geologic investigations and field and laboratory testing. Detailed review of the mechanisms of rock slope instability. Evaluation of the influence of geology, groundwater and blasting on rock slope stability. Design of stable rock slopes. Dewatering methods for rock slopes. Field instrumentation and monitoring of rock slope behaviour. Stabilization of rock slope failures. Design criteria.

*Textbooks (most recent edition is recommended):*

- Hoek, E., and J.W. Bray, Rock Slope Engineering, Institution of Mining and Metallurgy, London, UK.
- Mah, C., Taylor & Francis, Rock Slope Engineering: Civil and Mining.
- Lisle, R. J. and P.R. Leyshon, Stereographic Projection Techniques for Geologists and Civil Engineers, Cambridge University Press.

## 24-MMP-B9 Geotechnical Mining

Soil properties description and classification. Compaction. Lateral earth pressures assessment. Soil slope stability and open pit slopes design. Tailings dam construction design and analysis.

*Textbooks (most recent edition is recommended):*

- Das, B., Principles of Foundation Engineering, Cengage Learning.
- Canadian Geotechnical Society, Canadian Foundation Engineering Manual, 5th ed.
- McCarthy, D.F., Essentials of Soils Mechanics and Foundation, Prentice Hall.