

# Mining and mineral processing engineering syllabus

## Mining and mineral processing engineering examinations

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

#### 18-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 programmes, exploration geochemistry, devising drilling/trenching programmes, surveying techniques and remote sensing.

*Textbooks (most recent edition is recommended):*

- Kehew, A. E., General Geology for Engineers, 3rd Edition, Prentice Hall Canada Inc., Scarborough, Ontario, 2006. ISBN-10:0131457306. ISBN-13:9780131457300.
- Peters, William C., Exploration and Mining Geology, 2nd Edition, Wiley and Sons, 1987.
- Moon, C.J. et al, Introduction to Mineral Exploration, 2nd Edition, Blackwell, 2006.

#### 18-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, 2nd Edition, J. Wiley, New York, N.Y., 2003.
- Hustrulid, W.A. and Richard L. Bullock (ed.), Underground Mining Methods: Engineering Fundamentals and International Case Studies, SME, Littleton, CO, 2001.
- Gertsch, R.E. and R.L. Bullock (Ed.), Techniques in Underground Mining, SME, Littleton, CO, 1998.
- Darling, P. (Editor), SME Mining Engineering Handbook, Vol I & II, 3rd edition, SME Littleton, CO., 2011, 1984 p.
- 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.

#### 18-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, 8th edition, Butterworth Heinmann, 2016, 498 p.
- Darling, P. (Editor), SME Mining Engineering Handbook, Vol I & II, 3rd edition, SME Littleton, CO., 2011, 1984 p.
- Canadian Milling Practice, Special Volume 49, CIM, Montreal, 2000.

### 18-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, CO, 1998.
- Isaaks, E.H. and R.M. Srivastava, An Introduction to Applied Geostatistics, Oxford University Press, 1990.
- Gocht, W.R., H. Zantop and R. G. Eggert, International Mineral Economics, Springer-Verlag, 1988.
- Vogely, W.A. (Editor), Economics of the Mineral Industries, 4th edition, SME, Littleton, CO, 1985.
- Hartman, H. L. (Editor), SME Mining Engineering Handbook, 2nd edition, Vol I & II. SME Littleton, CO., 1992, 2394 pp (Chapters 5.6 & Chapter 6).
- Canadian Mining Taxation, latest edition, Price Waterhouse, Toronto.

### 18-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, 2nd edition, SME Littleton, CO., 1990, 1206p.
- Hartman, H. L., Introductory Mining Engineering, 2nd edition, J. Wiley, New York, N.Y., 2003.
- 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.

### 18-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):*

- Vick, S.G., Planning, Design, and Analysis of Tailings Dams, BiTech Publishers Ltd., Richmond, BC, reprinted 2005. ISBN: 0-921095-12-0.
- Bell, Fred and Laurence Donnelly, Mining and its Impact on the Environment, Routledge, 2006. ISBN: 0-315-28644-1.
- Darling, P. (Editor), SME Mining Engineering Handbook, Vol I & II, 3rd edition, SME Littleton, CO., 2011, 1984 p.
- Lottermoser, Bernd G., Mine Wastes: Characterization, Treatment and Environmental Impacts,

Springer, Berlin, New York, 2003. ISBN: 3540005269.

- Van Zyl, Dirk, Marshall Koval, Ta M. Li (eds.), Risk Assessment/Management issues in the Environment, SME, 1992. ISBN: 0-87335-115-0.
- Jambor, J.L., D.W. Blowes & AIM Ritchie, Environmental Aspects of Mine Wastes, Mineralogical Association of Canada. ISBN: 0-921294-31-x.
- Azcue, José M. (ed.), Environmental Impacts of Mining Activities: Emphasis on Mitigation and Remedial Measures, Springer, Berlin, New York, 1999. ISBN: 3540643443.

## Group B - Optional examinations (three required)

### 18-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.

### 18-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, 1999.
- Siskind, D.E., Vibrations from Blasting, International Society of Explosives Engineers, 2000.
- Persson, P.A., R. Holmberg, and J. Lee, Rock Blasting and Explosives Engineering, 1993. ISBN 084938978X

For OIQ in Quebec

- Quebec Government, Regulations respecting occupational health and safety in mines, S-2.1, r. 19.1, 56 p., 1996.
- Quebec Government, Regulations respecting pits and quarries, Q-2, r. 2, 56 p., 1985.

### 18-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):*

- Belt Conveyors for Bulk Materials, 4th Edition, Published by Conveyor Equipment Manufacturers Association, 1994.

- Darling, P. (Editor), SME Mining Engineering Handbook, Vol I & II, 3rd edition, SME Littleton, CO., 2011, 1984 p.
- Bise, C.J., Mining Engineering Analysis, Chapter 8, SME Inc., 1986.
- Caterpillar Performance Handbook, 2003, Edition 34.
- Das, B.M., Principles of Geotechnical Engineering, 2nd Edition, Chapter 2, PWS-KENT Publishing Company, 1990.
- Stanley, W.W., Mine Plant Design, 2nd Edition McGraw-Hill Inc., London, 1949.
- Kennedy, Bruce A., Editor, Surface Mining, 2nd Edition, SME Inc., 1990., pp. 672-723.
- Underground Mining Methods Handbook, SME Inc., 1982. Section 5 - Loading and Haulage - Chapter 8, pp. 1227-1266.
- Vertical Shaft Mining and Aerial Tramways, Wire Rope Industries Ltd, 1994.
- Occupational Health and Safety - Mines and Quarries, Government of Quebec Publication 2004.

## 18-MMP-B4 Occupational Health, Safety and Loss Management

Control and detection of hazards in surface and underground mines: rock falls, slope failures, radiation, heat, noise, dust and gas. Ventilation requirements for underground mines, air flow through mine openings, air quality and control. Workplace health and safety. Industrial hygiene in mining environment. Risk analysis, risk management, loss prevention and control.

*Textbooks (most recent edition is recommended):*

- Hartman, H.L., and others, Mine Ventilation and Air Conditioning, 2nd edition, John Wiley and Sons Inc., 1982.
- McPherson, M.J., Subsurface Ventilation & Environmental Engineering, Chapman & Hall, 1993.
- Darling, P. (Editor), SME Mining Engineering Handbook, Vol I & II, 3rd edition, SME Littleton, CO., 2011, 1984 p.
- Provincial Mine Regulations (for Province of Registration).
- Laird Wilson, Basic Learnings in Industrial Safety and Loss Management, APEGGA, Edmonton, 1998, 72 p.

## 18-MMP-B5 Mill 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, CO, 2002, 2410 p.
- A.L. Mular & 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.

## 18-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, adaptive, and supervisory. On-stream analysis and sampling for control; strategies for control of crushing, grinding, flotation, and dewatering circuits. 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, and D.A. Mellichamp, Process Dynamics and Control, 2nd Edition, Wiley, 2004, 736 p. ISBN: 0-471-00077-9.
- 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.

### 18-MMP-B7 Extractive Metallurgy (16-Chem-B7 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, 2nd Edition. Tapir Academic Press, Trondheim. 2004. ISBN 82-519-1922-3
- C. Bodsworth, The Extraction and Refining of Metals. CRC Press
- Moore, J. J., Chemical Metallurgy, 2nd edition, Butterworth-Heinemann, 1993. ISBN: 0750616466.

### 18-MMP-B8 Mine Management and Systems Analysis

Mine organization and mine management. Budgeting and management accounting. Industrial engineering — 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 — control networks (CPM, PERT), linear and nonlinear programming and simulation techniques. Experimental design. ISO 9000/14000 standard series.

*Textbooks (most recent edition is recommended):*

- Sloan, D.A., , Methuen Publications, Agincourt, Ontario, 1983.
- Carmichael, D.C., Engineering Queues in Construction and Mining, Horwood, 1987.
- Darling, P. (Editor), SME MinMine Management Engineering Handbook, Vol I & II, 3rd edition, SME Littleton, CO., 2011, 1984 p.
- Johnston, R.B. and Barnes, R.J. (Editors), Applications of Computers and Operations Research in the Mineral Industry, SME, Littleton, CO, 1982.
- Hicks, H.C., et al, The Management of Organizations, 4th edition, McGraw-Hill, Toronto, 1981.
- Winston, W.L., Operations Research, 3rd edition, Duxbury Press, 1994.
- Spinner, M., Elements of Project Management, Prentice Hall Inc., Englewood Cliff, N.J., 1981.

### 18-MMP-B9 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, 3rd Edition, Institution of Mining and Metallurgy, London, UK, 1981.
- Mah, C., Taylor & Francis, Rock Slope Engineering: Civil and Mining, 4th Edition, 2004.
- Lisle, R. J. and P.R. Leyshon, Stereographic Projection Techniques for Geologists and Civil Engineers, 2nd Edition, Cambridge University Press, 2006.