



Professional Engineers  
and Geoscientists of BC

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# **2009 MINING AND MINERAL PROCESSING ENGINEERING SYLLABUS and Checklist for Self-Evaluation**

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# MINING AND MINERAL PROCESSING ENGINEERING EXAMINATIONS SYLLABUS

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## GROUP A COMPULSORY EXAMINATIONS (6 REQUIRED)

### **09-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.

### **09-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.

### **09-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.

### **09-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.

### **09-MMP-A5 Surface Mining Methods and Design**

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.

### **09-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 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

**GROUP B**  
**ELECTIVE EXAMINATIONS (3 REQUIRED)**

**09-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. Field instrumentation, monitoring and control techniques, including seismic events, groundwater.

**09-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.

**09-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.

**09-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.

**09-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.

**09-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.

### **09-MMP-B7 Extractive Metallurgy**

Thermodynamics of pyro- and hydro-metallurgical extraction processes. Kinetics of extraction processes. 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.

### **09-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.

### **09-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.

## **MINING AND MINERAL PROCESSING – SUGGESTED TEXT LISTS - 2009**

### **09-MMP-A1 - General Geology and Exploration**

#### *Prime Texts:*

Kehew, A. E., General Geology for Engineers, 3<sup>rd</sup> Edition, Prentice Hall Canada Inc., Scarborough, Ontario, 2006. ISBN-10:0131457306. ISBN-13:9780131457300.

Peters, William C., Exploration and Mining Geology, 2<sup>nd</sup> Edition, Wiley and Sons, 1987.

#### *Supplementary Text:*

Moon, C.J. et al, Introduction to Mineral Exploration, 2<sup>nd</sup> Edition, Blackwell, 2006.

### **09-MMP-A2 – Underground Mining Methods and Design**

#### *Prime Texts:*

Hartman, H. L., Introductory Mining Engineering, 2<sup>nd</sup> 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.

#### *Supplementary Texts:*

Gertsch, R.E. and R.L. Bullock (Ed.), Techniques in Underground Mining, SME, Littleton, CO, 1998.

Hartman, H.L. (Editor), SME Mining Engineering Handbook, Vol I & II, 2<sup>nd</sup> edition, SME Littleton, CO., 1992, 2394 p (Vol. II, Part 4. Underground Mining, Sections 17 to 21).

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.

### **09-MMP-A3 - Mineral Processing**

#### *Prime Texts:*

Wills, Barry and Tim Napier-Munn, Mineral Processing Technology, 7<sup>th</sup> edition, Butterworth Heinmann, 2006, 456 p.

#### *Supplementary Texts:*

Hartman, H. L. (Editor), SME Mining Engineering Handbook, Vol I & II, 2<sup>nd</sup> edition, SME Littleton, CO., 1992, 2394p (Chapter 25.3).

Canadian Milling Practice, Special Volume 49, CIM, Montreal, 2000.

### **09-MMP- A4 - Mine Valuation and Mineral Resource Estimation**

#### *Prime Texts:*

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.

#### *Supplementary Texts:*

Gocht, W.R., H. Zantop and R. G. Eggert, International Mineral Economics, Springer-Verlag, 1988.

Vogely, W.A. (Editor), Economics of the Mineral Industries, 4<sup>th</sup> edition, SME, Littleton, CO, 1985.

Hartman, H. L. (Editor), SME Mining Engineering Handbook, 2<sup>nd</sup> edition, Vol I & II. SME Littleton, CO., 1992, 2394 pp (Chapters 5.6 & Chapter 6).

Canadian Mining Taxation, latest edition, Price Waterhouse, Toronto.

### **09-MMP-A5 Surface Mining Methods and Design**

#### *Prime Texts:*

Kennedy, B.A. (Editor), Surface Mining, 2<sup>nd</sup> edition, SME Littleton, CO., 1990, 1206p.

Hartman, H. L., Introductory Mining Engineering, 2<sup>nd</sup> edition, J. Wiley, New York, N.Y., 2003.

*Supplementary Texts:*

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.

**09-MMP-A6 - Mining and the Environment**

*Prime Texts:*

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.

*Supplementary Texts:*

Hartman, H. L. (Editor), SME Mining Engineering Handbook, Vol I & II, 2<sup>nd</sup> edition, SME Littleton, CO., 1992, 2394pp, (Chapter 12.1 - 12.3).

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.

**09-MMP-B1 - Applied Rock Mechanics**

*Prime Texts:*

Hoek, E. and Bray, J.N., Rock Slope Engineering, 3<sup>rd</sup> edition, Institution of Mining and Metallurgy, London, 1981.

Hoek, E. and Brown, E.T., Underground Excavations in Rock, Institution of Mining and Metallurgy, London, 1981.

*Supplementary Texts:*

Hartman, H. L., (Editor), SME Mining Engineering Handbook, Vol I & II, 2<sup>nd</sup> edition, SME Littleton, CO., 1992, 2394 p. (Chapter 10).

Brady, B.H.E. and Brown, Rock Mechanics for Underground Mining, 2<sup>nd</sup> edition, E.T. George Allen and Unwin, London, 1993.

**09-MMP-B2 - Rock Fragmentation**

*Prime Texts:*

Hustrulid, W., Blasting Principles for Open Pit Mining, Volume 1, General Design Concepts, and Volume 2, Theoretical Foundations, A.A. Balkema, 1999.

*Supplementary Texts:*

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.

### **09-MMP-B3 - Material Handling**

#### *Prime Texts:*

Belt Conveyors for Bulk Materials, 4<sup>th</sup> Edition, Published by Conveyor Equipment Manufacturers Association, 1994.

Hartman, H.L. (senior editor), Mining Engineering Handbook, 2<sup>nd</sup> Edition, Society of Mining Engineers, Inc, 1992., Chapters 13 and 17.

#### *Supplementary Texts:*

Bise, C.J., Mining Engineering Analysis, Chapter 8, SME Inc., 1986.

Caterpillar Performance Handbook, 2003, Edition 34.

Das, B.M., Principles of Geotechnical Engineering, 2<sup>nd</sup> Edition, Chapter 2, PWS-KENT Publishing Company, 1990.

Stanley, W.W., Mine Plant Design, 2<sup>nd</sup> Edition McGraw-Hill Inc., London, 1949.

Kennedy, Bruce A., Editor, Surface Mining, 2<sup>nd</sup> 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.

### **09-MMP-B4 - Occupational Health, Safety and Loss Management**

#### *Prime Texts:*

Hartman, H.L., and others, Mine Ventilation and Air Conditioning, 2<sup>nd</sup> edition, John Wiley and Sons Inc., 1982.

McPherson, M.J., Subsurface Ventilation & Environmental Engineering, Chapman & Hall, 1993.

#### *Supplementary Texts:*

Hartman, H. L., (Editor), SME Mining Engineering Handbook, Vol I & II, 2<sup>nd</sup> edition, SME Littleton, CO., 1992, 2394 p (Chapters 3.3 and 11).

Provincial Mine Regulations (for Province of Registration).

Laird Wilson, Basic Learnings in Industrial Safety and Loss Management, APEGGA, Edmonton, 1998, 72 p.

### **09-MMP-B5 - Mill Design and Operations**

#### *Prime Texts:*

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.

### **09-MMP-B6 - Mill Process Control**

#### *Prime Texts:*

Seborg, D.E., T.F. Edgar, and D.A. Mellichamp, Process Dynamics and Control, 2<sup>nd</sup> Edition, Wiley, 2004, 736 p. ISBN: 0-471-00077-9.

Considine, D.M. (ed), Process Instruments and Controls Handbook, 5<sup>th</sup> edition, McGraw-Hill, New York, 1999.

P.G. Claridge (ed.), Operation and Maintenance in Mineral Processing Plants, CIM, Vol.40, 1989, Section 9.

### **09-MMP-B7 - Extractive Metallurgy**

*Prime Text:*

Rosenqvist, T., Principles of Extractive Metallurgy, 2<sup>nd</sup> Edition. McGraw-Hill, 1983. ISBN: 0070665184.

*Supplementary Text:*

Moore, J. J., Chemical Metallurgy, 2<sup>nd</sup> edition, Butterworth-Heineman, 1993. ISBN: 0750616466.

### **09-MMP-B8 - Mine Management and Systems Analysis**

*Prime Text:*

Sloan, D.A., Mine Management, Methuen Publications, Agincourt, Ontario, 1983.

Carmichael, D.C., Engineering Queues in Construction and Mining, Horwood, 1987.

*Supplementary Text:*

Hartman, H. L., (Editor), SME Mining Engineering Handbook, Vol I & II, 2<sup>nd</sup> edition, SME Littleton, CO., 1992, 2394 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, 4<sup>th</sup> edition, McGraw-Hill, Toronto, 1981.

Winston, W.L., Operations Research, 3<sup>rd</sup> edition, Duxbury Press, 1994.

Spinner, M., Elements of Project Management, Prentice Hall Inc., Englewood Cliff, N.J., 1981.

### **09-MMP-B9 – Rock Slope Engineering**

*Prime Texts:*

Hoek, E., and J.W. Bray, Rock Slope Engineering, 3<sup>rd</sup> Edition, Institution of Mining and Metallurgy, London, UK, 1981.

Mah, C., Taylor & Francis, Rock Slope Engineering: Civil and Mining, 4<sup>th</sup> Edition, 2004.

*Supplementary Text:*

Lisle, R. J. and P.R. Leyshon, Stereographic Projection Techniques for Geologists and Civil Engineers, 2<sup>nd</sup> Edition, Cambridge University Press, 2006.

**The Association of  
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of British Columbia**

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**2009 MINING & MINERAL PROCESSING ENGINEERING SYLLABUS**

Checklist for Self Evaluation  
(Not for candidates who are assigned  
confirmatory exams)

Name: \_\_\_\_\_

Exam Number	Exam Name	Applicant' s Self- Evaluation - Course Equivalent	For Office Use Only
<i>Basic Studies (6 Required)</i>			
04-BS-1	Mathematics		
04-BS-2	Probability and Statistics		
04-BS-6	Mechanics of Materials		
04-BS-7	Mechanics of Fluids		
04-BS-11	Properties of Materials		
04-BS-14	Geology		
<i>Basic Studies (2 required)</i>			
04-BS-3	Statics and Dynamics		
04-BS-4	Electric Circuits and Power		
04-BS-5	Advanced Mathematics		
04-BS-8	Digital Logic Circuits		
04-BS-10	Thermodynamics		
<i>Group A (6 required)</i>			
09-Mmp-A1	General Geology and Exploration		
09-Mmp-A2	Underground Mining Methods and Design		

09-Mmp-A3	Mineral Processing		
09-Mmp-A4	Mine Valuation and Mineral Resource Estimation		
09-Mmp-A5	Surface Mining Methods and Design		
09-Mmp-A6	Mining and the Environment		
<b>Group B (3 Required)</b>			
09-Mmp-B1	Applied Rock Mechanics		
09-Mmp-B2	Rock Fragmentation		
09-Mmp-B3	Material Handling		
09-Mmp-B4	Occupational Health, Safety and Loss Management		
09-Mmp-B5	Mill Design and Operations		
09-Mmp-B6	Mill Process Control		
09-Mmp-B7	Extractive Metallurgy		
09-Mmp-B8	Mine Management and System Analysis		
09-Mmp-B9	Rock Slope Engineering		
<b>Complementary Studies (All Required)</b>			
11-CS-1	Engineering Economics		
11-CS-2	Engineering in Society – Health and Safety		
11-CS-3	Sustainability, Engineering and the Environment		
11-CS-4	Engineering Management		