

( *mathematics* )  *inEconomics*

# **Mathematical Methods in Economics: Problems and Solutions**

## Indexes

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## Index classifying the questions according to the main area of economics to which they relate

The questions are classified below according to the broad economic areas to which they relate. Some of the questions involve more than one area and are listed accordingly.

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- Allen, R. D. G., *Mathematical Economics*, London: Macmillan, 1956.
- Allen, R. D. G., *Mathematical analysis for economists*, London: Macmillan, 1938
- Archibald, G. C. and Lipsey, R. G., *An Introduction to A Mathematical Treatment of Economics*, London: Weidenfeld and Nicholson, 1973
- Baldani, J., Bradfield, J. and Turner, R., *Mathematical Economics*, Fort Worth; London: Dryden Press, 1996
- Baumol, W. J., *Economic Theory and Operations Analysis*, London: Prentice-Hall, 1977
- Bilas, R. A., *Microeconomic Theory*, New York; Maidenhead: McGraw-Hill, 1977
- Black, J. and Bradley, J. F., *Essential Mathematics for Economists*, London: Wiley, 1973
- Chiang, A. C. , *Fundamental Methods of Mathematical Economics*, New York: McGraw-Hill, 1967
- Cowell, F., *Measuring inequality*, Oxford: Philip Allen, 1977
- Dernberg, T. F. and McDougall, D. M., *Macroeconomics: the measurement, analysis, and control of aggregate economic activity*, New York: McGraw-Hill, 1980
- Gravelle, H. and Rees, R., *Microeconomics*, London: Longman, 1981
- Hands, D. Wade, *Introductory Mathematical Economics*, New York; Oxford: Oxford University Press, 2004
- Kogiku, K. C., *An introduction to macroeconomic models*, New York: McGraw-Hill, 1968
- Lambert, P. J., *Advanced mathematics for economists, static and dynamic optimisation*, Oxford: Blackwell, 1985
- Mueller, M. G. (ed), *Readings in Macroeconomics*, New York: Holt, Rinehart and Winston, 1966.
- Nicholson, W., *Microeconomic Theory: Basic Principles and Extensions*, Fort Worth: The Dryden Press, 1995.
- Pyndyck, R.R. and Rubinfeld, D. L., *Microeconomics*, New York: Macmillan, 1989
- Samuelson, P.A., *Economics: An Introductory Analysis*, New York: McGraw-Hill, 1948
- Sher, W. and Pinola, R., *Microeconomic Theory: a synthesis of classical theory and the modern approach*, London: Edward Arnold, 1981.
- Silberberg, E., *The structure of economics: a mathematical analysis*, Auckland: McGraw-Hill, 1981
- Smith, A., *A Mathematical Introduction to Economics*, Oxford: Blackwell, 1982
- Stein, S. K., *Calculus and Analytic Geometry*, Massachusetts: McGraw-Hill, 1992
- Varian, H. R., *Microeconomic Analysis*, New York: Norton, 1978