attain this bound. One of then, H_k, is constructed from $K_{n,n}$ by inserting a vertex of degree 2 on any one edge.

(b) The solution depends on the congruence class modulo 4. If $k=4m$, then $K_{2m,2m}$ is Eulerian and gives the maximum number of edges. If $k=4m+2$, the graph $K_{2m+1,2m+1}$ has odd degrees, but $K_{2m,2m+2}$ has all even degrees and only 1 fewer edge.

No other Eulerian bigraph has as many edges; and a triangle-free nonbigraph, by an argument similar to the one in part (a), has at most $4m^2+2m+1<4m^2+4m$ edges. Thus, the solution graph is unique.

If $k=4m+1$, the approach used in (a) guarantees that a nonbigraph has at most $4m^2+1$ edges. Graph H is Eulerian and attains the bound. If the maximum could possibly be attained by a bigraph, its vertices would be partitioned into sets of size $2a$ and $2b+1$. The vertices in the even set have even degree at most $2b$, and so the number of edges $\leqslant(2a)(2b)\leqslant 4m^2$. The graph H_k is just one of many Eulerian nonbigraphs attaining the maximum of $4m^2+1$ edges.

If $k=4m+3$, the nonbigraph bound is $4m^2+4m+2$, but the construction that attains this bound must give at least $4m-2$ vertices of odd degree. However, the graph J_k obtained by bisecting any edge of $K_{2m,2m+2}$ is Eulerian with $4m^2+4m+1$ edges.

Similarly to the preceding case, we find that an Eulerian bigraph has at most $(2a)(2b)\leqslant 4m^2+4m$ edges. Graph J_k is just one of many Eulerian nonbigraphs attaining the maximum.

Also solved by Ira Gessel.

A Characterization of Irrationals by Distribution of Residues

6161* [1977, 491]. *Proposed by Clark Kimberling, University of Evansville.*

For $0<r<1$, let $S(r)$ be the set of integers n such that one and only one integer lies in the open interval $(nr, nr+r)$. Prove or disprove that r is irrational if and only *if*, for every positive integer M, the set $S(r)$ contains a complete residue system modulo M.

Solution by W. C. Waterhouse, Pennsylvania State University. If r is rational with denominator M, there is no k in the interval for $n\equiv 0$ (modulo M). Let r be irrational, and choose arbitrary integers M and m with $0\leqslant m<M$. Then the multiples of $1/r$ are dense in the reals modulo M, whence some multiple k/r has its image in the image of the interval $(m, m+1)$. Then, for some integer q, we have $qM+m<k/r<qM+m+1$. Setting $n=qM+m$, this gives $n\equiv m$ (modulo M) and $nr<k<nr+r$.

Also solved by Mangho Ahuja, Kenneth L. Bernstein, John Bryant & Robert Gilmer, Michael W. Ecker, Kwang-Chul Ha, L. Kuipers (Switzerland), Joel Levy, Jordan I. Levy, L. E. Mattics, Jerry Metzger, Lewis Pakula, and Stefan Purobský (Czechoslovakia).

REVIEWS

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We invite readers to submit reviews of significant recent college-level mathematics books. We especially encourage reviews based on classroom use, or comparative reviews of several related books. Reviews should ordinarily not exceed two pages (per book) typed double spaced. Manuscripts of reviews as well as books submitted for review should be sent to: Book Review Editor, American Mathematical Monthly, St. Olaf College, Northfield, MN 55057.

Man and His Technology. By the Engineering Concepts Curriculum Project. McGraw-Hill, New York, 1973. xvi + 332 pp. Paperback. $12.50

The Engineering Concepts Curriculum Project, a group funded mostly by the National Science Foundation, at the State University of New York at Stony Brook, has produced books intended for "technology appreciation" courses for liberal arts students. Most of *Man and His Technology*, however, can be best described as a course in "applied mathematics appreciation." Here are some of the topics covered: Decision Making, which includes algorithms, optimization, and dynamic programming; Optimization, i.e., probability, queueing, games, and linear programming; Modeling, using graphs, population models, and exponential growth; Feedback, with goal-seeking, self-regulation, and instability; and Stability, with the epidemic model, and the law of supply and demand. There are nine chapters, usually of eight sections each.

Many topics are approached with much more motivation, and in somewhat less mathematical detail, than the same topics might be given in a college algebra or mathematics for business decisions text. On the other hand, the treatment of some of these topics—graphing inequalities, exponential functions, linear programming, two-person games—is probably sufficient for the level of mastery nontechnical students typically are expected to achieve in such courses; and the added motivation and selection of additional topics, such as seven bridges, queueing, systems with feedback, is very attractive. The writing style is often more like that of a history or psychology text than that of a standard mathematics text. Indeed, the exercises at the chapter ends are in that tradition: "Discuss the differences between dynamic and static models." "What examples of queue formation in your school can you think of? . . . Is it a single-service queue or a multi-service queue?" "Draw a block diagram which describes the feedback during a political campaign." There are very few computational exercises, and none of the repetitive computational drill usual in mathematics texts.

This book would lend itself very well to an "applied mathematics appreciation" course for nontechnical students. It could be used without supplementary material for a semester course, if the instructor was content to place little emphasis on computational work, for example by giving essay tests. A somewhat more traditional course would require the instructor to provide supplementary examples and exercises and could cover a few chapters in one semester or much of the book in two; such a course would overlap considerably, but not completely, the usual courses in college algebra or mathematics for business-decisions courses. In particular, unlike most traditional mathematics texts, the book is highly appropriate for interdisciplinary courses and team-taught courses crossing departmental lines.

A predecessor volume, *The Man-Made World* (of which *Man and His Technology* is in large part a reprinting) has been used as the principal text in a year-long, six semester hour, team-taught course at Memphis State University. The course contained roughly two to three semester hours of college algebra and some other mathematical material. The students, who were well motivated but had weak mathematical backgrounds, received the book much better than they would have a traditional mathematics textbook.

EDWARD T. ORDMAN, New England College

A First Course in Probability. By Sheldon Ross. Macmillan, New York, 1976. x + 305 pp. \$14.95. (Telegraphic Review, May 1976.)

This book was used in a one-semester probability course at the junior-senior level for students whose minimum background was a year of calculus and our sophomore sequence of linear algebra and differential equations. We covered the first eight chapters at a comfortable pace, treating, in order, counting principles, axioms of probability, conditional probability, discrete random variables, continuous random variables, joint random variables, expectation, and limit theorems.

I prefer a problem-solving approach to probability at the post-calculus level and selected