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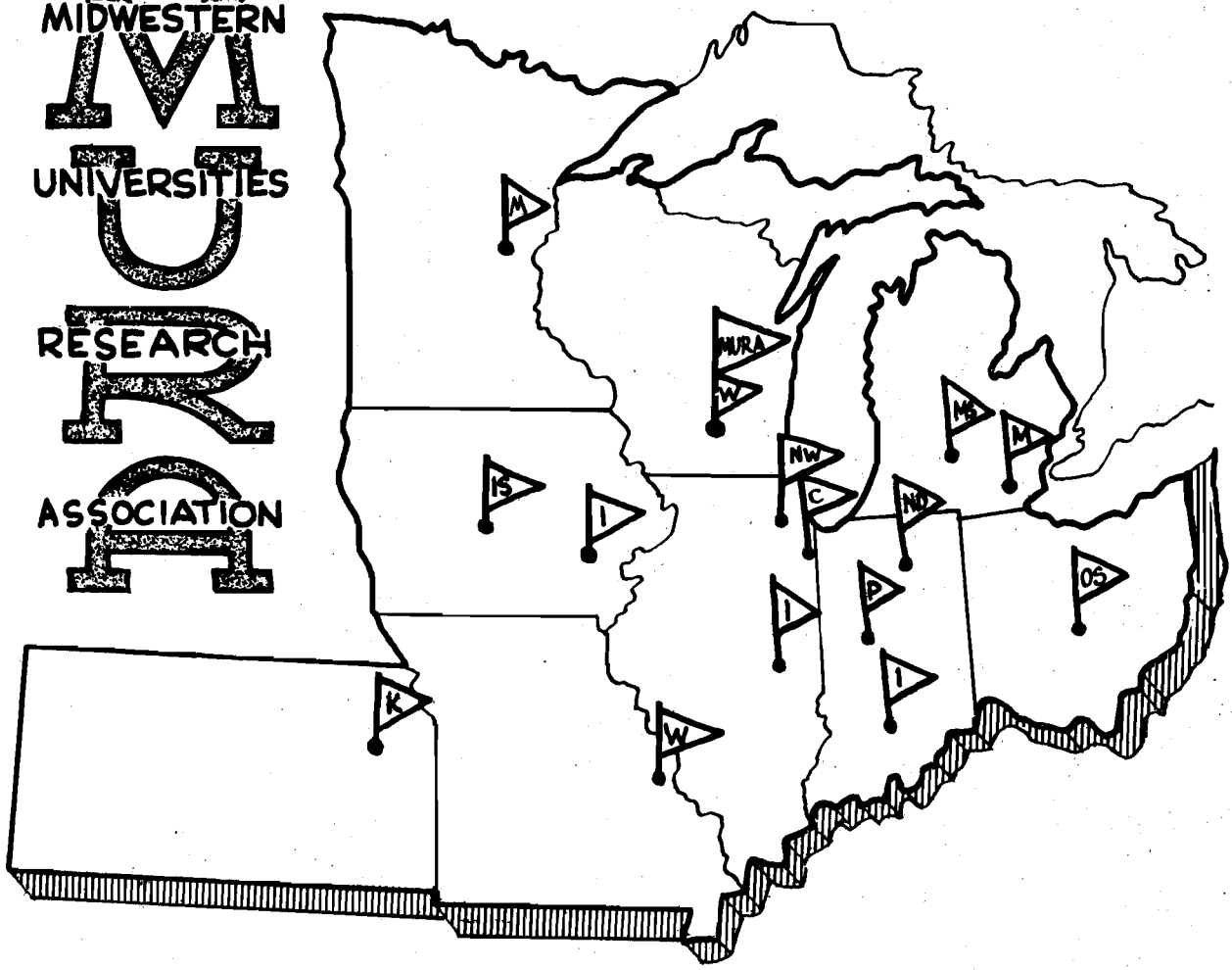

REPORT TEMPERMESH
(Problem 76)
March, 1957

NUMBER 241
Internal
(IBM Program)

TEMPERMESH
(Problem 76)

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These notes are presented to guide the users of the program known as "Tempermesh." Programming details and methodology are not presented here. A familiarity with "Well Tempered Five" and "Formesh" is assumed.

The Tempermesh program computes the magnetic field components at prescribed mesh points according to the following equations, described by Powell in MURA-JLP 6:

$$
\begin{aligned}
H_x &= (1+x)^k \sum_{i=1}^{\infty} \sum_{m=0}^{M} (\alpha_{im} \cos m\Phi + \beta_{im} \sin m\Phi) \frac{(y/1+x)^{2i-1}}{(2i-1)!}, \\
H_y &= -(1+x)^k \sum_{i=0}^{\infty} \sum_{m=0}^{M} (\mu_{im} \cos m\Phi + \nu_{im} \sin m\Phi) \frac{(y/1+x)^{2i}}{(2i)!}, \qquad (1) \\
H_\theta &= (1+x)^k N \sum_{i=1}^{\infty} \sum_{m=0}^{M} m(\nu_{i-1,m} \cos m\Phi - \mu_{i-1,m} \sin m\Phi) \frac{(y/1+x)^{2i-1}}{(2i-1)!},
\end{aligned}
$$

where

$$
\begin{aligned}
\Phi &= K \ln(1+x) - N\theta, \\
K &= 1/w
\end{aligned}
\qquad (2)
$$

and the coefficents μ_{im}, ν_{im}, α_{im} and β_{im} appearing above are obtained from the recurrence relations,

$$
\begin{aligned}
\mu_{i+1,m} &= \{m^2(K^2+N^2) - (k-2i)^2\}\mu_{im} - 2mK(k-2i)\nu_{im}, \\
\nu_{i+1,m} &= 2mK(k-2i)\mu_{im} + \{m^2(K^2+N^2) - (k-2i)^2\}\nu_{im}, \qquad (3) \\
\alpha_{i+1,m} &= -(k-2i)\mu_{im} - mK\nu_{im}, \qquad \alpha_{om} = 0, \\
\beta_{i+1,m} &= mK\mu_{im} - (k-2i)\nu_{im}, \qquad \beta_{om} = 0.
\end{aligned}
$$

The field is thus computed according to the same equations as in the Well Tempered Five program. In fact the magnetic field computation portion of the two programs is identical.

Tempermesh then prepares a printed listing of the values of the magnetic field at the desired mesh points and a Mesh Deck (like that produced by Forocyl) suitable for use with Formesh, Atemesh or Sixteenmesh.

As in the Well Tempered Five the user specifies the median plane field by giving the values of $\mu_{00}, \mu_{01}, \mu_{02} \cdots \mu_{0M}, \nu_{00}, \nu_{01}, \ldots \nu_{0M}$. The series expressions for the field are truncated as before by specifying either i_{max} or ϵ.* The bounds on i_{max} and M remain the same, namely, $1 \leq i_{max} \leq 24$ and $0 \leq M \leq 30$.

The mesh is specified by the user via the usual parameters a, b and r: a is the number of mesh points in a row, b is the number of mesh points on a column, and r is the ratio of vertical to horizontal grid size. As in the other mesh programs the ξ, η coordinate system is used, where

$$\xi = \frac{1}{2\pi}\left\{K \ln(1+x) - N\theta\right\}$$
$$\eta = \frac{1}{2\pi}\sqrt{K^2 + N^2}\,\frac{y}{1+x} \tag{4}$$

The mesh coordinates are pictured below in Fig. 1

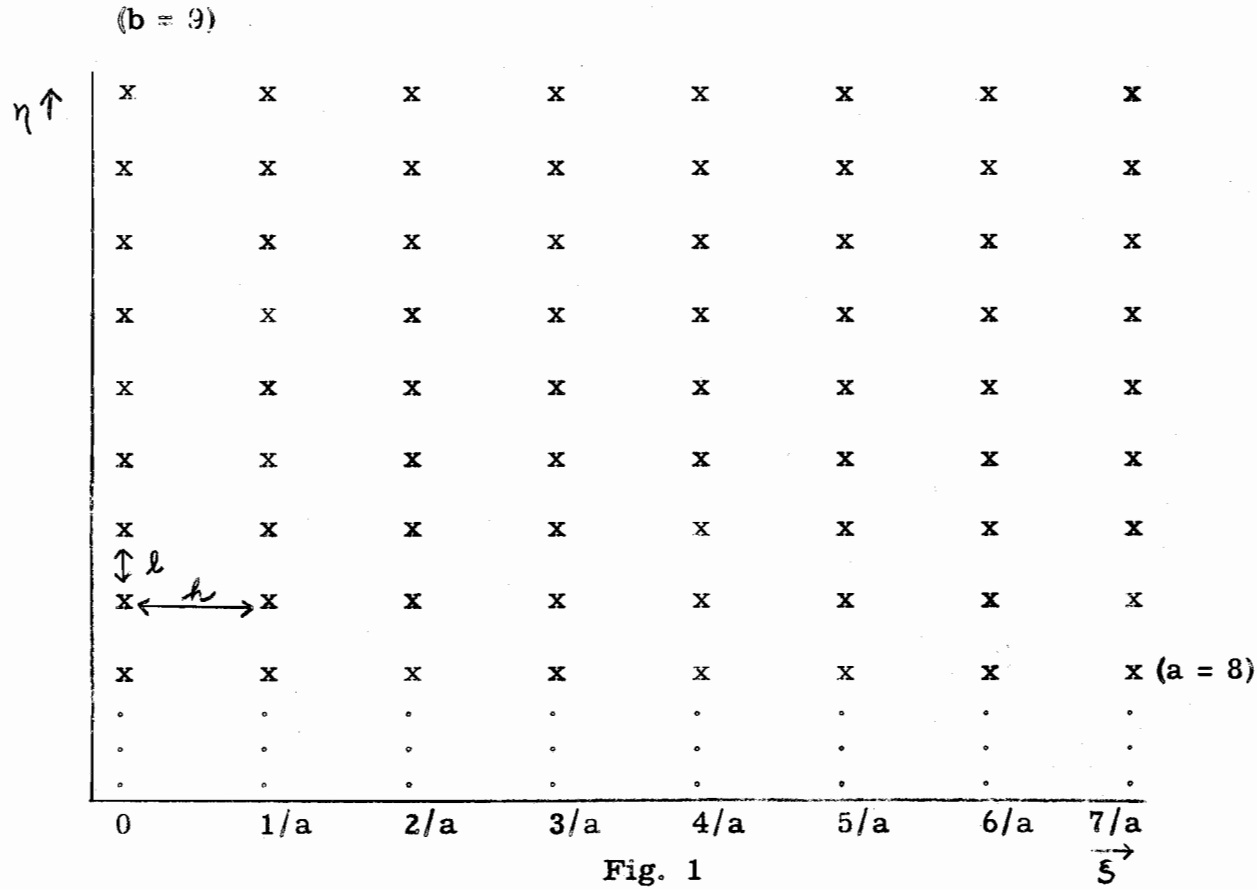

Fig. 1

*See page 3 of the Well Tempered Five write-up.

We note that

$$h = 1/a, \tag{5}$$

and

$$\ell = r h. \tag{6}$$

A sample agendum follows on pages 4 and 5. Standards for entry of floating point numbers on the agendum are described in detail in the Well Tempered Five write-up.

An initial print of the input data is prepared by the program. This initial print is on a page by itself and the numbers appear in five columns on lines numbered 0 through 18. Page 6 gives the format for this initial print. It is to be noted that line number 3 will be missing whenever SS3 is up--that is, whenever i_{max} is inserted by the user.

The printed listing of the magnetic field values at the mesh points is a three column standard* floating point print with a "line numbering" column at the left. The quantities printed are

$$\begin{aligned} 2^{-6} h_\theta &= 2^{-6} \frac{H_\theta}{(1+x)} k, \\ 2^{-6} h_x &= 2^{-6} \frac{H_x}{(1+x)} k, \\ 2^{-6} h_y &= 2^{-6} \frac{H_y}{(1+x)} k. \end{aligned} \tag{7}$$

The line number is a 5 digit integer defined by the relation

line number = 1000 x (row number) + (column number),

thus identifying the mesh point to which the three quantities $2^{-6}h_\theta$ in column 1, $2^{-6}h_x$ in column 2 and $2^{-6}h_y$ in column 3, refer. The row numbers, going from the bottom to the top of the mesh, are 0, 1, . . . b-1 and the column numbers, going from left to right, are 0, 1, 2. . . a-1. A sample output for mesh points in row number 6 and in columns numbered 40 through 53 is shown below in Figure 2.

*The standard floating point printed number is described on page 12 of the Well Tempered Five write-up.

TEMPERMESH AGENDUM (PROGRAM 76)

Parameter	Address	Value		Remarks	
ID	3097				FIXED POINT INTEGERS
i_{max}	3094			Last term in power series for H_x, H_y, H_z : $0 < i_{max} \leq 24$, need to specify only when SS3 UP	
		n	exp		
1/w	3064				FLOATING POINT NUMBERS
k	3065				
N	3066				
r	3067			ratio of vertical to horizontal grid size: r = 1/h	
a	3068			number of mesh points on a row	
b	3069			number of mesh points on a column	
ϵ	3093			specify when SS3 DOWN	

TEMPERMESH AGENDUM (PROGRAM 76)

Fourier coefficients of the median plane field

$H_y = (1 + x)^k \sum \{\mu_{0,m} \cos m\Phi + \nu_{0,m} \sin m\Phi\}$

Parameter	Address	Value n	Value exp	Parameter	Address	Value n	Value exp	
$\mu_{0,30}$	3113			$\nu_{0,30}$	3144			FLOATING POINT NUMBERS
$\mu_{0,29}$	3114			$\nu_{0,29}$	3145			
$\mu_{0,28}$	3115			$\nu_{0,28}$	3146			
$\mu_{0,27}$	3116			$\nu_{0,27}$	3147			
$\mu_{0,26}$	3117			$\nu_{0,26}$	3148			
$\mu_{0,25}$	3118			$\nu_{0,25}$	3149			
$\mu_{0,24}$	3119			$\nu_{0,24}$	3150			
$\mu_{0,23}$	3120			$\nu_{0,23}$	3151			
$\mu_{0,22}$	3121			$\nu_{0,22}$	3152			
$\mu_{0,21}$	3122			$\nu_{0,21}$	3153			
$\mu_{0,20}$	3123			$\nu_{0,20}$	3154			
$\mu_{0,19}$	3124			$\nu_{0,19}$	3155			
$\mu_{0,18}$	3125			$\nu_{0,18}$	3156			
$\mu_{0,17}$	3126			$\nu_{0,17}$	3157			
$\mu_{0,16}$	3127			$\nu_{0,16}$	3158			
$\mu_{0,15}$	3128			$\nu_{0,15}$	3159			
$\mu_{0,14}$	3129			$\nu_{0,14}$	3160			
$\mu_{0,13}$	3130			$\nu_{0,13}$	3161			
$\mu_{0,12}$	3131			$\nu_{0,12}$	3162			
$\mu_{0,11}$	3132			$\nu_{0,11}$	3163			
$\mu_{0,10}$	3133			$\nu_{0,10}$	3164			
$\mu_{0,9}$	3134			$\nu_{0,9}$	3165			
$\mu_{0,8}$	3135			$\nu_{0,8}$	3166			
$\mu_{0,7}$	3136			$\nu_{0,7}$	3167			
$\mu_{0,6}$	3137			$\nu_{0,6}$	3168			
$\mu_{0,5}$	3138			$\nu_{0,5}$	3169			
$\mu_{0,4}$	3139			$\nu_{0,4}$	3170			
$\mu_{0,3}$	3140			$\nu_{0,3}$	3171			
$\mu_{0,2}$	3141			$\nu_{0,2}$	3172			
$\mu_{0,1}$	3142			$\nu_{0,1}$	3173			
$\mu_{0,0}$	3143			$\nu_{0,0}$	3174			

SENSE SWITCH

i_{max} PLANTED	SS3 UP	
COMPUTE i_{max}	SS3 DOWN	

NOTE:

1. Value = n x 10^{exp}, where $1 \leq |n| < 10$, or zero, and n may contain from 1 to 9 decimal digits. n and exp are assumed positive unless indicated by -. exp is understood zero when blank; $|exp| \leq 9$.
2. If this is one run of a series, only those values differing from those of the preceding run need be specified.
3. If this run does not belong to a series, then all quantities not specified are set equal to zero.
4. Agenda of a series should be submitted with sheets stapled together in order of running.

Initial Print Format

ID	Col. 1	Col. 2	Col. 3	Col. 4	Col. 5
0	Prob #	run #			
1	a	b			
2	1/w	k	N	r	
3	ϵ	ϵ'	this line missing if SS3		UP
4	i_{max}				
5	$\mu_{0,30}$	$\mu_{0,29}$	$\mu_{0,28}$	$\mu_{0,27}$	$\mu_{0,26}$
6	$\mu_{0,25}$	$\mu_{0,24}$	$\mu_{0,23}$	$\mu_{0,22}$	$\mu_{0,21}$
7	$\mu_{0,20}$	$\mu_{0,19}$	$\mu_{0,18}$	$\mu_{0,17}$	$\mu_{0,16}$
8	$\mu_{0,15}$	$\mu_{0,14}$	$\mu_{0,13}$	$\mu_{0,12}$	$\mu_{0,11}$
9	$\mu_{0,10}$	$\mu_{0,9}$	$\mu_{0,8}$	$\mu_{0,7}$	$\mu_{0,6}$
10	$\mu_{0,5}$	$\mu_{0,4}$	$\mu_{0,3}$	$\mu_{0,2}$	$\mu_{0,1}$
11	$\mu_{0,0}$				
12	$\nu_{0,30}$	$\nu_{0,29}$	$\nu_{0,28}$	$\nu_{0,27}$	$\nu_{0,26}$
13	$\nu_{0,25}$	$\nu_{0,24}$	$\nu_{0,23}$	$\nu_{0,22}$	$\nu_{0,21}$
14	$\nu_{0,20}$	$\nu_{0,19}$	$\nu_{0,18}$	$\nu_{0,17}$	$\nu_{0,16}$
15	$\nu_{0,15}$	$\nu_{0,14}$	$\nu_{0,13}$	$\nu_{0,12}$	$\nu_{0,11}$
16	$\nu_{0,10}$	$\nu_{0,9}$	$\nu_{0,8}$	$\nu_{0,7}$	$\nu_{0,6}$
17	$\nu_{0,5}$	$\nu_{0,4}$	$\nu_{0,3}$	$\nu_{0,2}$	$\nu_{0,1}$
18	$\nu_{0,0}$				

A deck of cards containing these same quantities in suitable form for use as the Mesh Deck by Formesh, Atemesh or Sixteenmesh is prepared. The printing of the field may be suppressed and only the Mesh Deck produced by putting sense switch 4 up. This results in a saving of time but the absence of a printed record is generally undesirable.

Mesh Point	$2^{-6}h_e$	$2^{-6}h_x$	$2^{-6}h_y$
06040	-30645059- 4	24887528- 3	10602413- 3
06041	-24939301- 4	20746688- 3	14841226- 3
06042	-19135847- 4	16439828- 3	18278272- 3
06043	-13257733- 4	11984059- 3	20901118- 3
06044	-73275648- 5	73965041- 4	22700340- 3
06045	-13677560- 5	26944698- 4	23669312- 3
06046	45992661- 5	-21043800- 4	23804204- 3
06047	10551144- 4	-69820970- 4	23103976- 3
06048	16465267- 4	-11920184- 3	21570390- 3
06049	22318709- 4	-16899550- 3	19208058- 3
06050	28088075- 4	-21900367- 3	16024546- 3
06051	33749523- 4	-26902095- 3	12030466- 3
06052	39278655- 4	-31883381- 3	72396221- 4
06053	44650501- 4	-36822028- 3	16691815- 4

Fig. 2: Sample output for mesh points in row number 6 and in columns 40 through 53.

As in Well Tempered Five a series of agenda may be submitted. The agendum sheets of a series must be stapled together and SERIES must be clearly written on the top agendum sheets. In this mode the program does not reset the parameters to zero on successive problems but "remembers" the parameter values from the preceding problem of the series. Only those parameters which have a value differing from the one on the preceding run need to be entered on the agendum.

The running time for this program may be estimated from the following equation:

Running time (seconds) = $ab\,(.0167\, i_{max}\,(m_{max} + 1) + .600)$,

or if printing is suppressed