Polynomial Curve Fitting with Excel

EAS 199A Fall 2011

Overview

Practical motivation: fitting a pump curve

- Get data from the manufacturer.
- Use Excel's TRENDLINE function to fit polynomials to the data.
- Extract the polynomial coefficients for later use.

Note: This example uses pump data from a manufacturer. For the pump project assignment, use the measured data for your pump.

Sample pump data

A circulating pump from the Grainger Catalog

- http://www.grainger.com
- Select "pump" under Product Category
- Select "Centrifugal" under "Narrow your search by" (or click on the Centrifugal Pump panel in the center of the page)
- Select "Self priming pressure pumps"
- As an example, pick the first pump: Goulds GT10



Direct link (24 November 2010) http://www.grainger.com/Grainger/GOULDS-Centrifugal-Pump-1N440

🔘 🔘 🕐 Pump, Centrifugal, 1 HP – Self Priming Pressure Pumps – Centrifugal – Pumps : Grainger Industrial Supply									
+ http://www.	.grainger.com/Grainger,	/GOULDS-Centrifugal	-Pump-1N440 d	C Google)			
🛱 🇰 hack bots = email = tode	o▼ HR = ME▼ GWR▼	EAS 199 TME 370	▼ News▼ LWTL▼	EET▼ Energy▼	tools v 🛛	>>			
Pump, Centrifugal, 1 HP - Self Pri.						÷			
F	Iome Sign In Your Acc	count Register			1 0 Items	n			
	Catalog 401	Find a Branch		Search					
Products Resources	Services	Worldwide	Repair Parts	About Us	Today				
GOULDS Pump, Centr	rifugal, 1 HP								
Pumps > Centrifugal > Self Priming	Pressure Pumps								
Centrifugal Pump, Power Rating 1 HP, Voltage @ 60 Hz 115/230 Volts, Phase Single, Full Load Amps 16.2/8.1, Motor Enclosure ODP, NPT Inlet 1 1/2 Inches, Outlet Port 1 1/2 Inches, Length 19 7/8 Inches, Height 9 1/4 Inches, Width 8 1/4 Inches, Self Priming									
Grainger Item #	1N440					ľ			
Price (ea.)	\$483.00	2.2	Val Sta			L			
Brand	GOULDS	1-1-11	BEREAL PROPERTY			L			
Mfr. Model #	GT10		1			L			
Ship Qty. ?	1					L			
Sell Qty. (Will-Call) ?	1					L			
Ship Weight (lbs.)	50.6					L			
Usually Ships** 🔋	Today					L			
Catalog Page No.	3573 💷					L			
Country of Origin (Country of Origin is subject to change.)	USA	G Er	nlarge Image			L			
See Notes & Restrictions for important safety information. Qty Add Grainger TripleGuard® repair & replacement coverage ? for \$89.95 each.									
👾 Add to Order 🛛 🗛 Add to Personal L	ist 🚺 🔶 Compare Altern	ates)							
Price shown may not reflect your price. Sign in a	or register.								
Tech Additional Con Specs Information Re	npliance & MSDS	Required Accessories	Optional Accessories	Alternate Re Products Pa	pair arts	4			
C Loading "http://www.orainger.com/Crainge	r/COULDS-Centrifugal-Pum	n-1N440" completed 17	of 18 items) + +	1			
county http://minigranger.com/drange	ay course continugar run	p 134110, completed 17	0. 20 memo			111			

Loading "http://www.grainger.com/Grainger/GOULDS-Centrifugal-Pump-1N440", completed 17 of 18 items

▲ ► @ + ■ http://www.	grainger.com/Grainger/GOULDS-Centrifugal-Pump-1N440 C Qr Google	
hack bots = email = todo	▼ HR = ME ▼ GWR ▼ EAS 199 ▼ ME 370 ▼ News ▼ LWTL ▼ EET ▼ Energy ▼ tools ▼	•
Pump, Centrifugal, 1 HP - Self Pri		
Tech Additional Com Specs Information Res	pliance & Required Optional Alternate Repair trictions MSDS Accessories Accessories Products Parts	
m	Centrifugal Pump	
/pe	Self-Priming	
7		
altage	115/230	
nos	162/81	
1	60	
let (In.)	1-1/2	
utlet (In.)	1-1/2	
iction Lift (Ft.)	5	
ength (In.)	19-7/8 Scholl down	
idth (In.)		
eight (In.)	9-1/4	
PM @ 10 PSI	60	
PM @ 15 PSI	56	
PM @ 20 PSI	53	
PM @ 25 PSI	47	
PM @ 30 PSI	43	
2M @ 35 PSI	38	
2M @ 40 PSI	29	
PM @ 45 PSI	18	
DECOURT (PC)	110	
IX. Pressure (PSI) est Efficiency CDM @ Head (Et)	51	
et Efficiency Grin @ Head (Ft.)	30 @ 35 40.60 GPM @ 80-30 Et	
st Enclosure		
MA/IEC Frame	561	
M	350	
rvice Factor	115	
atted Materials	CI Norvi Lexan Carbon Ceramic and Buna	
using Material	Cast Iron	
peller Material	Norvi	
lute Material	Cast Iron	
al Type	Mechanical Shaft	
al Material	Carbon, Ceramic, Buna	
al Application	Water	
aft Material	Stainless Steel	
rew Material	Steel	
PM of Water @ 2 Ft. of Head	140	
ermal Protection	Automatic Reset	
x. Specific Gravity	1.0	
ax. Case Pressure (PSI)	125	
ax. Fluid Viscosity	40 SSU	
et Pressure (PSI)	25	
peller Type	Closed	
uty Dia Calida (in)	Continuous	
ax. Dia. Solids (In.)	1/10	
ort Rotation		
1 (51)		

🔘 🔘 🕘 Pump, Centrifugal, 1 HP	P – Self Priming Pressure Pumps – Centrifugal – Pumps : Grainger Industrial Supp	ly
◄ ►	grainger.com/Grainger/GOULDS-Centrifugal-Pump-1N440 C Q- Google	
hack bots = email = todo	O▼ HR = ME▼ GWR▼ EAS 199▼ ME 370▼ News▼ LWTL▼ EET▼ Energy▼ too	ls▼ ≫
Pump, Centrifugal, 1 HP – Self Pri		+
Tech Additional Com Specs Information Res	npliance & Required Optional Alternate Repair strictions MSDS Accessories Accessories Products Parts	
Item	Centrifugal Pump	
Туре	Self-Priming	
HP		
Phase	1	
Ampe	113/230	
Hz	60	
Inlet (In.)	1-1/2	
Outlet (In.)	1-1/2	
Suction Lift (Ft.)	5	
Length (In.)	19-7/8 Pump curvo data	
Width (In.)		
GPM @ 10 PSI	60	
GPM @ 15 PSI	56	
GPM @ 20 PSI	53	
GPM @ 25 PSI	47	
GPM @ 30 PSI	43	
GPM @ 35 PSI	38	
GPM @ 40 PSI	29	
Shut Off (Et)	10	
May Proceiro (PSI)	51	
Rest Efficiency CRM @ Head (Et)	50 @ 55	
Best Efficiency Range GPM @ Head (Ft.)	40-60 GPM @ 80-30 Ft.	
Motor Enclosure	ODP	
NEMA/IEC Frame	56J	
RPM	3500	
Service Factor	1.15	
Wetted Materials	CI, Noryl, Lexan, Carbon, Ceramic and Buna	
Housing Material	Cast Iron	
Impeller Material	Noryi Cost Iron	
Seal Type	Udstition Machanical Shaft	L
Seal Material	Carbon Ceramic Buna	
Seal Application	Water	
Shaft Material	Stainless Steel	
Screw Material	Steel	
GPM of Water @ 2 Ft. of Head	140	
Thermal Protection	Automatic Reset	
Max. Specific Gravity	1.0	
Max. Case Pressure (PSI)	125	
Max. Fluid Viscosity	40 550	
Iniet Pressure (PSI)	20 Olegad	
Duty	Continuous	
May Dia Solide (In)	1/16	
Port Rotation	TOP	
B B	0.07	

Polynomial Curve Fit with Excel

- I. Store the data
- 2. Make a scatter plot
- 3. Right-click on data, and "add a trendline"
 - (a) Select Polynomial, dial-in the desired order
 - (b) Check boxes to display equations and R2
 - (c) Select "Options" in the list on the left, click the "Custom" radio button, and add "Cubit fit" in the text box for the custom label
 - (d) Close dialog box
- 4. Right-click on the legend and select "format trendline label"
 - (a) Select "Number" in the list on the left and "Scientific" and the Category for the number format
 - (b) Change data to scientific notation with 3 or 4 decimal places
 - (c) Select "Font" in the list on the left, and increase the font size to make the text legible

Manually extracting the curve fit coefficients

- I. Suppose the data is in columns A and B, rows 7 through 15
- 2. Suppose you want a cubic fit
- 3. Enter these formulas in empty cells

=Index(LINEST(B7:B15,A7:A15^{1,2,3}),1,1) =Index(LINEST(B7:B15,A7:A15^{1,2,3}),1,2) =Index(LINEST(B7:B15,A7:A15^{1,2,3}),1,3) =Index(LINEST(B7:B15,A7:A15^{1,2,3}),1,4)

=Index(LINEST(B7:B15,A7:A15^{{1,2,3},1,0),1,3)</sup>

The first four lines give the coefficients of the cubit polynomial. The last line gives the value of R^2

	A	В	
1	Pump curv	e for Goulds	GT
2		Grainger Ca	talc
3		http://www.g	grain
4			
5			
6	Q (GPM)	h (psi)	
7	60	10	
8	56	15	
9	53	20	
10	47	25	
11	43	30	
12	38	35	
13	29	40	
14	18	45	
15	0	51	
16			

Finished spreadsheet

	A	В	С	D	E		F	G	Н	1		K
1	Pump curv	e for Gould	s GT10									
2		Grainger Ca	atalog, Part	Number	1N440 (Ca	talog 40	01, Nove	mber 201	0)			
3		http://www.	grainger.com	/Grainger,	/GOULDS-Ce	ntrifugal	-Pump-1N	440				
4												
5				60								1
6	Q (GPM)	h (psi)		~		y = -1.1	495E-04x	³ + 1.9462E-	-04 x² - 2.839	7E-01 x + 5.094	6E+01	
7	60	10						R ² = 9	.9822E-01			
8	56	15		50								
9	53	20					-					
10	47	25		40			-					
11	43	30		5				~				
12	38	35		u 30								
13	29	40		Ē					\searrow		 Data 	
14	18	45		20							Cubic fit	
15	0	51										
16									~	N		
17				10						v		
18												
19				0 +		20	20					
20				0	10	20	30	40	50	60 70		
21							Flow ra	ite (GPM)				
22												1
23												
24	Cubic polyno	mial coefficie	nts									
25	1	-1.1495E-04										
26	2	1.9462E-04										
27	3	-2.8397E-01										
28	4	5.0946E+01										
29	R2	9.9822E-01										
30												