ENGINEERING ECONOMICS

Formulas

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SOURCE: Gayatri Mam's notes

DEMAND

Elasticity of Demand:

Income Elasticity:

$$E_Y = \frac{\Delta Q}{\Delta Y}\frac{Y}{Q}$$

Q	Quantity of demand
Y	Income of consumer

Cross Elasticity:

$$E_{XY} = \frac{P_Y}{Q_X}\frac{\Delta Q_X}{\Delta P_Y}$$

Q_X	Quantity of demand of good X
P_Y	Price of another good Y

Price Elasticity:

$$E_P = \frac{P}{Q}\frac{\Delta Q}{\Delta P}$$

Q	Quantity demand
P	Price of the same good

Price Elasticity using different methods:

Total Outlay Method/ Total Expenditure Method:

p	Price of the good	
q	Quantity of good sold	
T_E	Total Expenditure	$= pq$
p'	New price of the good	$= p - \Delta p$
q'	New quantity of the good sold	$= q + \Delta q$
Δp	Change in price	$= p - p'$
Δq	Change in quantity demand	$= q' - q$
T'_E	New Total Expenditure	$= p'q'$

If	$T'_E > T_E$	then	$E_P > 1$
If	$T'_E < T_E$	then	$E_P < 1$
If	$T'_E = T_E$	then	$E_P = 1$

Point Method:

$$E_P = \frac{length\ of\ demand\ curve\ below\ the\ point}{length\ of\ demand\ curve\ above\ the\ point}$$

Arc Method:

$$p = \frac{p_1 + p_2}{2}$$ p_1 and p_2 are prices corresponding to two points on arc

$$q = \frac{q_1 + q_2}{2}$$ q_1 and q_2 are quantities corresponding to two points on arc

$$E_P = \frac{(p_1+p_2)}{(q_1+q_2)} \frac{\Delta q}{\Delta p}$$

Revenue Method:

Total Expenditure	T_E	pq	
Total Revenue	TR	pq	
Average Revenue	AR	$= \frac{TR}{q} = p$	
Marginal Revenue	MR	$MR_n = TR_n - TR_{n-1}$	discrete
		$MR = \frac{d(TR)}{dq}$	general
Price Elasticity	E_P	$= \frac{AR}{AR-MR}$	

SUPPLY

Price Elasticity E_P $= \frac{p}{q} \frac{\Delta q}{\Delta p}$

PRICE DETERMINATION

(In perfect competitive market)

Quantity of demand $Q_d\,(p, q)$
Quantity of supply $Q_s\,(p, q)$

Solve both the equations to get values of p and .
The solution p and q will be equilibrium price and equilibrium quantity resp.

PRODUCTION

Total sale quantity	S	
Total production	TP	
Average production	AP	$= \frac{TP}{S}$
Marginal production	MP	$= TP_n - TP_{n-1} = \frac{\Delta TP}{\Delta S}$

Note: When MP = 0, then, TP is max.

COST

Break Even Analysis

Number of Units of Product	n	
Selling Price of each unit	p	
Total Cost	C	$= nV + F$
Fixed Cost	F	
Variable Cost	V	
Total Profit	z	$= R - C = n(p - V) - F$
Net Profit	z'	
Rate of tax	t	
Seller's Revenue (actual sales)	R	$= np$
Break Even Quantity	b_0	
Break Even Sales	S_b	$= b_0 p$
Contribution	C_0	$= pn - V$

At Break Even point, $z = 0$ and $n = b_0 = \frac{F}{p-V}$

Break Even Sales = $b_0 p = \frac{pF}{C_0} = \frac{pF}{p-V} = \frac{F}{1-\frac{V}{p}}$

$$Margin\ of\ Safety = Actual\ Sales - Break\ Even\ Sales = R - S_b$$
$$= \frac{profit * break\ even\ sales}{contribution} = \frac{profit^* b_0 p}{C_0}$$

Where, $profit = C_0 - F$

DEPRECIATION

Straight Line Method:

Initial Value/ cost I (capital i)
Salvage Value S
Life of the asset (in years) n

Depreciation Charges $DC = \frac{I-S}{n}$

Book Value at the end if i^{th} year $BV_i = I - i * DC$

Rate of depreciation D $= \frac{DC}{I} * 100\%$

Declining Balance Method:

Also known as Diminishing Balance Method
(or) Reducing Balance Method

Initial Value/ cost I (capital i)
Salvage Value S
Life of the asset (in years) n

Rate of Depreciation $R = 1 - \left(\frac{S}{I}\right)^{\frac{1}{n}}$

Book Value $BV_i = I(1-R)^i$

$= I * \left(\frac{S}{I}\right)^{\frac{i}{n}}$

Depreciation Charges $DC_i = \frac{R}{n} * BV_{i-1}$

TIME VALUE OF MONEY

(Interest Formulas)

Principal amount/ Present Value	P
Number of interest periods	n
Interest Rate	i
Future amount at the end of nth year	F
Annuity	A
Uniform amount added/ subtracted - after each interest period	G

1. Single Payment – Compound Interest / Future Value of Amount

$$F = P(1+i)^n \qquad = P(\,F/P\,,i,\ n)$$

2. Single Payment – Present Worth Amount

$$P = \frac{F}{(1+i)^n} \qquad = F(\,P/F\,,i,\ n)$$

3. Equal Payment Series – Compound Future Value of Annuity

$$F = A * \left(\frac{(1+i)^n - 1}{i}\right) \qquad = A(\,F/A\,,\ i\,,\ n)$$

4. Equal Payment Series – Sinking Fund

$$A = F * \left(\frac{i}{(1+i)^n - 1}\right) \qquad = F(\,A/F\,,\ i,\ n)$$

5. Equal Payment Series – Present Worth Amount

$$P = A * \left(\frac{(1+i)^n - 1}{i(1+i)^n}\right) \qquad = A(\,P/A\,,\ i\,,n)$$

6. Equal Payment Series – Capital Recovery Amount

$$A = P * \left(\frac{i(1+i)^n}{(1+i)^n - 1}\right) \qquad = P(\,A/P\,,\ i\,,n)$$

7. Uniform Gradient series

$$F = \frac{G}{i}\left(\frac{(1+i)^n - 1}{i}\right) - \frac{nG}{i} \qquad = G(\,A/G\,,\ i,\ n)$$

EVALUATION OF ENGINEERING ALTERNATIVES

1. Present Worth Method

Revenue Method

Irregular Series

$$PW(i) = -P + \left(\sum_{k=1}^{n} \frac{R_k}{(1+i)^k}\right) + \frac{S}{(1+i)^n}$$
$$= -P + \left(\sum_{k=1}^{n} R_k(P/F,\ i,\ k)\right) + S(P/F\ ,\ i\ ,\ n)$$

Where, R_k is the revenue of i[th] year

Regular Series

$$PW(i) = -P + R(P/A\ ,\ i,\ n) + S(P/F\ ,\ i,\ n)$$

Where, R is the average revenue

Cost Method

Irregular Series

$$PW(i) = +P + \left(\sum_{k=1}^{n} \frac{C_k}{(1+i)^k}\right) - \frac{S}{(1+i)^n}$$
$$= +P + \left(\sum_{k=1}^{n} C_k(P/F,\ i,\ k)\right) - S(P/F\ ,\ i\ ,\ n)$$

Where, C_k is the cost of i[th] year

Regular Series

$$PW(i) = +P + C(P/A\ ,\ i,\ n) - S(P/F\ ,\ i,\ n)$$

Where, C is the average cost

2. Future Worth Method

Revenue Method

Irregular Series

$$FW(i) = -P(1+i)^n + \left(\sum_{k=1}^{n-1} R_k(1+i)^{n-k}\right) + R_n + S$$
$$= -P(F/P\,,\ i,\ n) + \left(\sum_{k=1}^{n-1} R_k(F/P\,,\ i,\ n-k)\right) + R_n + S$$

Where, R_k is the revenue of i^th year

Regular Series

$$FW(i) = -P(F/P\,,\ i,\ n) + R(F/A\,,\ i,\ n) + S$$

Where, R is the average revenue

Cost Method

Irregular Series

$$FW(i) = +P(1+i)^n + \left(\sum_{k=1}^{n-1} C_k(1+i)^{n-k}\right) + C_n - S$$
$$= +P(F/P\,,\ i,\ n) + \left(\sum_{k=1}^{n-1} C_k(F/P\,,\ i,\ n-k)\right) + C_n - S$$

Where, C_k is the cost of i^th year

Regular Series

$$FW(i) = +P(F/P\,,\ i,\ n) + C(F/A\,,\ i,\ n) - S$$

Where, C is the average cost