Production and Operations Management
Spring Semester 2023/2024

FORMULAS SHEET

Inventory Management

EOQ

$Q = \sqrt{\frac{2DS}{H}}$; N = D/Q ; ROP = d × L ;

$$TC = \frac{Q}{2} \times H + \frac{D}{Q} \times S + P \times D$$

POQ

$$Q = \sqrt{\frac{2DS}{H(1-\frac{d}{p})}}$$

$$TC = \frac{Q}{2}(1 - \frac{d}{p}) \times H + \frac{D}{Q} \times S + P \times D$$

$t_p = t_1 = \frac{Q}{p}$ $T = \frac{Q}{D}$ $N = \frac{D}{Q}$ $I_{máx} = M = Q(1 - \frac{d}{p})$

Probabilistic Models

$$SS = Z_{\alpha}\sigma_{dLT}$$

$$ROP = \mu_{LT} \times \mu_d + SS$$

$$\sigma_{dLT} = \sqrt{\mu_d^2 \times \sigma_{LT}^2 + \mu_{LT} \times \sigma_d^2}$$

$$ROP = LT \times \mu_d + SS$$

$$\sigma_{dLT} = \sqrt{LT} \times \sigma_d$$

$$ROP = \mu_{LT} \times d + SS$$

$$\sigma_{dLT} = \sqrt{d^2 \times \sigma_{LT}^2}$$

$$\alpha = P(X > ROP) = \text{probability of stockout}$$

$$TC = \left(\frac{Q}{2} + SS\right) \times H + \frac{D}{Q} \times S + P \times D$$

Project Management

EF = ES + Activity time

LS = LF – Activity time

Slack = LS – ES or Slack = LF– EF

Crash cost per period = $\frac{CC - NC}{NT - CT}$

Expected activity time = t = $\frac{a + 4m + b}{6}$

Variance of activity completion time = $\left[\frac{(b-a)}{6}\right]^2$

Waiting Line Models

$L_q = \lambda \times W_q$; $L_S = \lambda \times W_S$; $L_S = L_q + \lambda / \mu$; $W_S = W_q + 1/\mu$

M/M/1

$L_q = \dfrac{\lambda^2}{\mu(\mu - \lambda)}$; $L_S = \dfrac{\lambda}{\mu - \lambda}$ $W_q = \dfrac{\lambda}{\mu(\mu - \lambda)}$; $W_S = \dfrac{1}{\mu - \lambda}$

$\rho = \dfrac{\lambda}{\mu}$; $P_0 = 1 - \rho$ $P_n = P_0 \times \left(\dfrac{\lambda}{\mu}\right)^n$ $P(n > k) = \rho^{k+1}$

M/M/S

$$P_0 = \frac{1}{\left[\sum_{n=0}^{S-1} \frac{1}{n!}\left(\frac{\lambda}{\mu}\right)^n\right] + \frac{(\lambda/\mu)^S}{S!} \times \frac{S\mu}{S\mu - \lambda}} \quad (S\mu > \lambda)$$

$$Lq = \frac{\lambda \times \mu \times \left(\frac{\lambda}{\mu}\right)^S}{(S-1)!\,(S\mu - \lambda)^2} P_0 \qquad \rho = \frac{\lambda}{S\mu}$$

$$P_n = \frac{\left(\frac{\lambda}{\mu}\right)^n}{n!} P_0 \;\; (n \le S) \qquad P_n = \frac{\left(\frac{\lambda}{\mu}\right)^n}{S!\,S^{n-S}} P_0 \;\; (n > S)$$

M/D/1

$L_q = \dfrac{\lambda^2}{2\mu(\mu - \lambda)}$; $W_q = \dfrac{\lambda}{2\mu(\mu - \lambda)}$ $\rho = \dfrac{\lambda}{\mu}$

$P_0 = 1 - \rho$

Scheduling

$CR = \dfrac{Due\ Date - Today's\ date}{Work(lead)\ time\ remaining}$

$Utilization = \dfrac{Total\ job\ work\ time}{Total\ flow\ time}$

$Average\ completion\ time = \dfrac{Total\ Flow\ Time}{Number\ of\ jobs}$

$Average\ job\ lateness = \dfrac{Total\ late\ days}{Number\ of\ jobs}$

$Average\ number\ of\ jobs\ in\ the\ system = \dfrac{Total\ flow\ time}{Total\ job\ work\ time}$

Statistical Process Control

$UCL_{\bar{X}} = \bar{\bar{X}} + A_2 \times \bar{R}$ $LCL_{\bar{X}} = \bar{\bar{X}} - A_2 \times \bar{R}$ $CL_{\bar{X}} = \bar{\bar{X}}$ $UCL_R = D_4 \times \bar{R}$; $LCL_R = D_3 \times \bar{R}$ $CL_R = \bar{R}$ $C_{pk} = \min(C_{pki}; C_{pks})$ $C_p = \dfrac{USL - LSL}{6 \times \sigma}$ $C_{pki} = \dfrac{\mu - LSL}{3 \times \sigma}$ e $C_{pks} = \dfrac{USL - \mu}{3 \times \sigma}$	$UCL_c = \bar{c} + 3 \times \sqrt{\bar{c}}$ $LCL_c = \bar{c} - 3 \times \sqrt{\bar{c}}$ $CL_c = \bar{c}$ $UCL_p = \bar{p} + 3 \times \sqrt{\dfrac{\bar{p}(1-\bar{p})}{n}}$ $LCL_p = \bar{p} - 3 \times \sqrt{\dfrac{\bar{p}(1-\bar{p})}{n}}$ $CL_p = \bar{p}$

Capacity and Constraint Management

$$\text{Utilization} = \frac{\text{Atual Output}}{\text{Design Capacity}}$$

$$\text{Efficiency} = \frac{\text{Atual Output}}{\text{Effective Capacity}}$$

$$\text{Capacity} = \frac{1}{\text{Cycle time}}$$