### National Exams December 2012

## 07-Mec-B4, Integrated Manufacturing Systems

#### 3 hours duration

#### NOTES:

- 1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
- This is an OPEN BOOK EXAM.
   Any non-communicating calculator is permitted.
- 3. Any five questions constitute a complete paper. Only the first five (5) questions as they appear in your answer book will be marked.
- 4. Each question is of equal value.
- 5. Some questions require an answer in essay format. Clarity and organization of the answer are important.

- 1. a) The cost of producing between 1,500 units and 2,500 units of a product consists of \$25,000 fixed cost and \$10-per-unit variable cost. With the selling price at \$20 per unit, what is the break-even point? Suppose the price per unit was increased to \$25. How does this affect the break-even point?
  - b) A new machine has a cost of \$24,000, an estimated economic life of eight years, and a salvage value of \$4,000 at the end of the eight-year period. Assume that the annual operating costs will be \$3,000 per year and the going rate of interest is 10 percent. What is the present value of new expenditures for the machine?
- 2. A component is expected to encounter a maximum stress of 40,000 psi. Past data on similar components show that the standard deviation of *strength* is about 10 percent of the average strength. What specification should be set on average strength to achieve a safety margin of 3.0? 4.0? 5.0? (Assume that strength is distributed normally.)
- 3. a) Discuss the necessity of close cooperation between the product engineer and the process engineer.
  - b) What is the function of the standard process sheet?
  - c) The Welch Manufacturing Company is a new firm being started to manufacture power lawn mowers. What information would be needed to make a decision as to whether or not it should be planned for continuous or intermittent manufacture?

4. An electronics firm has just won a contract to manufacture two products (A and B) for the government. The firm has three departments – design, manufacture, and test. The design department has finished its work, and now it is up to manufacturing to actually start production.

The contract stipulates that 1,000 A's and 2,000 B's must be made over the next 30 working days. It is management's objective to produce the product on straight time (i.e., an eight-hour work day). Other data about the case are as follows:

Standard time per unit A 20 hours Standard time per unit B 5 hours Set-up time per unit A 3 hours Set-up time per unit B 2 hours Number of batches 1 for A and 1 for B Standard set-up time per batch A 16 hours Standard set-up time per batch B 10 hours Organizational efficiency including operator productivity 80%

- a) How many workers are required to complete the project on time?
- b) Halfway through the project, the government asks if you can add another 300 A's to the contract. Assume that you can react instantaneously by pulling workers off other projects. (This will entail a separate batch of A.) For this remaining 15 days, how many additional workers are required?
- 5. a) List the major symptoms of a poor plant layout.
  - b) Name three basic layouts for product flow. Discuss briefly the advantages of each layout.
  - c) What are the strengths and weaknesses of the functional type of organization?

6. A small service organization has four departments arranged as shown in the figure below, on the left, with interdepartment distances based on the center of departments A, B, C and D. The number of trips between departments during a typical week is given on the right. The department sizes are appropriate, and the cost of a trip is primarily a function of distance. What do you think of the present layout? Would you suggest any changes?

20'		
A	В	1 <b>0'</b>
С	D	

	A	В	С	D
A	-	25	15	20
B	·	-	20	10 ·
С			-	5
D				-

# Laplace Transform Table

$\mathcal{F}$ . If $\mu$ becomes $m$ , $\mathcal{F}(s)$	Tinks hunding (i.e. 188	
I	Unit-impulse function $\delta(t)$	
1	Unit-step function u,(f)	
$\frac{1}{d^2}$	Unit-ramp function s	
nl .	f" (n = positive integer)	
i s+α	e <sup>−st</sup>	
$\frac{1}{(s+\alpha)^2}$	le <sup>-ul</sup>	
$\frac{n!}{(s+\alpha)^{s+1}}$	$t^n e^{-\alpha t}$ ( $n = positive integer$ )	
$\frac{1}{(s+\alpha)(s+\beta)}$	$\frac{1}{\beta-\alpha}(e^{-\alpha}-e^{-\beta})\ (\alpha\neq\beta)$	
$\frac{s}{(s+\alpha)(s+\beta)}$	$\frac{1}{\beta - \alpha} (\beta e^{-\beta r} - \alpha e^{-\alpha}) \ (\alpha \neq \beta)$	
$\frac{1}{s(s+\alpha)}$	$\frac{1}{\alpha}(1-e^{-\omega})$	
$\frac{1}{s(s+\alpha)^2}$	$\frac{1}{\alpha^2}(1-e^{-\alpha t}-\alpha t e^{-\alpha t})$	
$\frac{1}{s^2(s+\alpha)}$	$\frac{1}{\alpha^2}(\alpha r - 1 + e^{-\alpha r})$	
$\frac{1}{s^2(s+\alpha)^2}$	$\frac{1}{\alpha^{2}}\left[t-\frac{1}{\alpha}+\left(t+\frac{2}{\alpha}\right)e^{-nt}\right]$	

## Laplace Transform Table (continued)

POF STREET	er office dinction ( ) (0)	
$\frac{s}{(s+\alpha)^{1}}$	(1 – αβε <sup>~ul</sup>	
$\frac{\omega_{\kappa}^{2}}{s^{2}+\omega_{\kappa}^{3}}$	Sin ea <sub>c</sub> t	
$\frac{s}{s^2 + \omega_a^2}$	COS W <sub>A</sub> f	
$\frac{\omega_{\pi}^2}{s(s^1 + \omega_{\pi}^2)}$	1 — cos ω <sub>e</sub> f	
$\frac{\omega_s^2(s+\alpha)}{s^2+\omega_s^2}$	$ \frac{\omega_{\alpha}\sqrt{\alpha^{2}+\omega_{\alpha}^{2}}\sin(\omega_{\alpha}t+\theta)}{\text{where }\theta=\tan^{-1}(\omega_{\alpha}t\alpha)} $	
$\frac{\omega_a}{(s+\alpha)(s^3+\omega_a^2)}$	$\frac{\omega_a}{\alpha^1 + \omega_a^2} e^{-\alpha t} + \frac{1}{\sqrt{\alpha^2 + \omega_a^2}} \sin(\omega_a t - \theta)$ where $\theta = \tan^{-1}(\omega_a/\alpha)$	
$\frac{\omega_a^4}{s^2 + 2\xi \omega_a s + \omega_a^2}$	$\frac{\omega_{\epsilon}}{\sqrt{1-\zeta^2}}e^{-i\omega_f}\sin\omega_{\epsilon}\sqrt{1-\zeta^2}t \qquad (\zeta<1)$	
$\frac{\omega_a^2}{s(s^2+2\underline{\zeta}\omega_a s+\omega_a^2)}$	$1 - \frac{1}{\sqrt{1 - \ell^2}} e^{-\theta d} \sin(\omega_a \sqrt{1 - \ell^2} t + \theta)$ where $\theta = \cos^{-1} \ell$ $(\ell < 1)$	
$\frac{s\omega_n^2}{s^2 + 2\zeta\omega_n s + \omega_n^2}$	$\frac{-\omega_a^2}{\sqrt{1-\zeta^2}}e^{-\theta \cdot \zeta}\sin(\omega_a\sqrt{1-\zeta^2}t-\theta)$ where $\theta = \cos^{-1}\zeta$ ( $\zeta < 1$ )	
$\frac{\omega_a^2(s+\alpha)}{s^2+2\zeta\omega_a s+\omega_a^2}$	$\omega_a \sqrt{\frac{\alpha^2 - 2\alpha \zeta \omega_c + \omega_a^2}{1 - \zeta^2}} e^{-i\omega_s} \sin(\omega_c \sqrt{1 - \zeta^2} t + \theta)$ where $\theta = \tan^{-1} \frac{\omega_c \sqrt{1 - \zeta^2}}{\alpha - \zeta \omega_a}$ ( $\zeta < 1$ )	
$\frac{\omega_n^2}{s^2(s^2+2\underline{\zeta}\omega_n s+\omega_n^2)}$	$i - \frac{2\zeta}{\omega_o} + \frac{1}{\omega_o^2 \sqrt{1 - \zeta^2}} e^{-i\omega_c t} \sin(\omega_o \sqrt{1 - \zeta^2} t + \theta)$ where $\theta = \cos^{-1}(2\zeta^2 - 1)$ $(\zeta < 1)$	