Course: **Introduction to Engineering**

Unit: **Engineering Economics**

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1. INTRODUCTION

1.1 IMPORTANCE OF ECONOMICS FOR ENGINEERS

- Economics is concerned with allocation of resources in a society, while engineering involves the use of resources to solve problems and to satisfy specific needs for the society.
- It is important for engineers to have a basic understanding of economics, in order to utilise resources optimally, and to better balance the three "legs" of any engineering project (cost, schedule and performance).

1.2 SCOPE OF THIS LECTURE

This module provides students with a high-level overview of the following:

- **Basics of Economics**, introducing concepts such as scarcity of resources and its effects on production; consumer-, production-, private- and public products and services; different economic systems; engineering efficiency versus economic efficiency; marginal analysis; direct-, indirect- and opportunity cost; production limitations; inflation; and present- and future values.
- **Budgeting**, addressing some major advantages of budgeting; accounting numbers versus cash flows; guidelines for compiling a cash flow budget for a production business; and some reasons why budgeting is often neglected.
- **Investment decisions**, addressing investment evaluation techniques such as internal rate of return, net present value, payback period, benefit-cost ratio, and return on investment; choosing the best investment opportunity when capital availability is constrained; and influence of risk on business investment decisions.

2. BASICS OF ECONOMICS

2.1 INTRODUCTION

- Resources can be defined as anything that helps to produce products and services wanted by people.
- The four main groups of resources are: manpower, materials, money, and machines – often called the *four Ms*.
- In all aspects of life, scarcity of resources exists for individuals and for societies.
- Scarcity results from people's unlimited wants, which must be satisfied with limited resources.
- Scarcity requires choices to be made; and *economics* is the study of the choices about allocation of resources to satisfy wants in the light of scarcity.
- The fundamental question in economics is: "How can individuals and societies optimally satisfy their wants, with limited resources?"

- This question can be split into three:
  - **What** must be produced?
  - **How** must the selected products and services be produced?
  - **For whom** must it be produced?
- As a subject, economics is commonly studied on two levels:
  - **Microeconomics** – e.g. the demand for and supply of specific items, and the resulting prices and price changes; the salaries of specific groups of people, and its relation to salaries of other groups, etc.
  - **Macroeconomics** (the "big picture") – e.g. the level of a nation's output, inflation, unemployment, international trade, taxes, government spending and economic policy, etc.
- The following are general references on economics: EPPING 1995, HEILBRONER & THUROW 1998, JACOBS 2000, KEYNES 1997, MARSHALL 1997, and SMITH 1991. (The books by Keynes and Smith are reprints of two of the best known classical works on economics.)
- The term *engineering economics* (RIGGS *et al* 1997) is commonly used to refer to the allocation of resources in an engineering organisation.

2.2 TYPES OF PRODUCTS AND SERVICES

- Products and services produced for consumption are called *consumer products / services*, e.g.:
  - Bread baked by the local bakery (consumer product).
  - A television news bulletin (consumer service).
  - A car produced for private use by a family (consumer product).
- *Production products / services* (sometimes also called *capital-* or *industrial* products / services) are produced as a resource for further production (of consumer- or of other production products / services), e.g.:
  - A robot arm for use as part of a vehicle assembly plant (production product).
  - Machines and tools, e.g. lathes, screwdrivers, hammers, etc. (production products).
  - Maintenance done on a radio station's transmitters (production service).
- Both consumer products / services and production products / services can be classified as either:
  - *Private products or services*, which are bought and used by individuals, such that the consumption affects nobody else.
  - *Public products or services*, which are provided through collective action - e.g. street lighting, public roads, national defence, etc. The provision of public products necessitates central (government) involvement in the allocation and use of resources.

2.3 ECONOMIC SYSTEMS

- There are three main types of economic systems:

- *Centrally planned economies*: a small group of people decides on the allocation of resources.
- *Capitalist (market) economies*: forces of demand and supply ("the market") allocate the resources.
- *Traditional economies*: an individual's position in society (e.g. the king or the chief) determines the allocation of resources.

- Most economies are a mix of the above three types, but about 75% of the world's production comes from predominantly market economies.
- "The market" is not a single place, but can be defined as the bringing together of consumers and producers in order that:
  - prices of products and services can be determined; and
  - exchanges of products and services can take place (for other products / services or for money).
- There are many different types of markets, e.g.:
  - fresh produce markets, where mainly fresh agricultural products are exchanged;
  - money markets, where different countries' currencies are exchanged;
  - stock markets, where shares in various companies are exchanged; etc.
- These markets can be "real markets" where consumers and producers meet in person, and where products / services are physically exchanged for other products, services, or money.
- The markets can also be "virtual markets", where exchanges take place by means of computerised trading.
- Whatever the type of market, resource prices are determined by competition for the resources; and this allows *supply and demand* to form prices as follows (DEBREU & DEBREU 1986; MARSHALL 1997):
  - When the demand for a specific product/service is high, while the supply thereof is low, the price will be forced up by competition for the limited resources.
  - When the price goes up, the demand will decrease, because some people won't be able to afford it anymore.
  - Also when the price goes up, more people might be willing to produce the specific product / service. The supply will thus also increase.
  - This process will continue until supply and demand come into balance again.
  - The process is similar when demand is low, and supply is high: prices will fall; demand will go up, while supply will decrease, until equilibrium is reached.

2.4 EFFICIENCY OF RESOURCE UTILISATION

- Efficiency of resource utilisation (output-input ratio) is important to ensure that scarce resources are not wasted.
- There are two types of efficiency of resource utilisation:

- *Engineering efficiency*: production of products or services of a certain quality, while maximising the output-input ratio.
- *Economic efficiency*: engineering efficiency plus obtaining the maximum possible satisfaction of people's needs.

- Two bridges next to each other to cross a river can both be engineering efficient, but since one of the two will be redundant, it will not be economically efficient.
- Engineers often focus on product functionality, with little concern for economic efficiency.
- It is the task of the engineering manager to help an engineering team to take product functionality one step further in order to reach engineering efficiency; and then to take engineering efficiency one step further in order to reach economic efficiency.
- One possible way of reaching the goal of economic efficiency is to:
  - analyse the potential advantages from all possible combinations of resource allocation, and
  - then choose the resource allocation with the highest advantage.
- Consider the following example:
  - A man lives 6 km from his work.
  - He can walk the full distance, or he can use the bus for up to 5 km of the route.
  - The bus fare is determined by "zone", and not by distance.
  - If he arrives up to 29 minutes earlier at work, he is not paid more. If he arrives 30 to 59 minutes earlier than the official starting time, he gets paid for an extra half hour.
  - By considering the potential advantages from different resource allocations – as shown in the next table - the man can choose the option which will maximise his income.

Distance travelled by bus [km]	Distance walked [km]	Bus fare [$]	Time earlier at work [minutes]	Extra income from being at work earlier [$]	Extra income *minus* bus fare [$]
0	6	0	0	0	0
1	5	3	10	0	-3
2	4	5	20	0	-5
3	3	5	30	30	25
4	2	7	40	30	23
5	1	7	50	30	23

  - From the above analysis it is clear that it is best for the man to walk 3 km and use the bus for 3 km, since that will bring him an extra net income of $25 per day.
  - (Note that factors such as wear and tear on his shoes, positive or negative health impact, and discomfort due to the walking - i.e. the *indirect- and opportunity costs* - had not been accounted for in this simple example. Refer to section 2.6 below for a brief discussion of these costs.)

2.5 MARGINAL ANALYSIS

- The above method of analysis to determine efficiency of resource utilisation is only viable for a small number of resource allocation combinations.

- When multiple combinations of resource allocations are possible, it is better to use *marginal analysis* (ALBOUY 1983).
- Consider the following (rather simple) example:
  - A road in a rural area can be extended to make it easier for farmers to reach the market with their products, and for consumers to get to the market to buy the products.
  - This will benefit the local economy, since more people will have access to the products, the farmers will have more income, and the local market will do more business.
  - Assume that a detailed economic analysis shows:

Length of road extension [km]	**Cost [$ millions]**	**Unit cost [$M / km]**	**Benefits [$ millions]**	**Benefits *minus* Cost [$ millions]**
1	2	2	3	1
2	3	1,5	5	2
3	4	1,33	9	5
4	6	1,5	12	6
5	10	2	13	3
6	14	2,33	14	0
7	18	2,57	15	-3

  - The unit cost [$M / km] differs from one road length to another, because the route goes through varying terrain.
  - From the above table it is clear that:
    - The lowest unit cost is attained by extending the road for 3 km.
    - The project will break even if the road is extended for 6 km.
  - However, neither lowest unit cost, nor the break even point is a useful decision making criterion, since:
    - The lowest unit cost (zero) can really be attained by not extending the road at all.
    - At break even, nothing is gained by the whole project.
  - Since the objective is not necessarily to break even or to have the lowest unit cost, a different decision-making criterion is required.
  - The alternative is *marginal analysis*, which involves:
    - Plot the "benefits *minus* cost" determined in the above table, versus the road length.
    - Determine the road length where the maximum value of "benefits *minus* cost" occurs.
    - This is then the optimum road length.
  - The latter procedure is equivalent to determining the point where the benefit-cost ratio (efficiency of resource utilisation) is maximum – similar to differentiation in calculus, used to determine minima and maxima of a curve, by determining where its slope equals zero.
  - For the road extension example, the marginal analysis is aided by the following table:

	1 km	2 km	3 km	4 km	5 km	6 km	7 km
Total benefit ($M)	3	5	9	12	13	14	15
Marginal benefit ($M)	-	2	4	3	1	1	1
Total cost ($M)	2	3	4	6	10	14	18
Marginal cost ($M)	-	1	1	2	4	6	4
Marginal benefit *minus* Marginal cost ($M)	-	1	3	1	-3	-5	-3

- The table shows:
  - To build the first 1 km will cause $2M costs, but will bring $3M benefits – i.e. the net advantage is $1M.
  - To extend the road from 1 km to 2 km will have $1M extra costs, but will bring $2M extra benefits – i.e. the net **marginal (incremental) advantage** is $1M.
  - To extend the road from 2 km to 3 km will have $1M extra costs, but will bring $4M extra benefits – i.e. the net marginal advantage is $3M.
  - To extend the road from 3 km to 4 km will have $2M extra costs, but will bring $3M extra benefits – i.e. the net marginal advantage is $1M.
  - To extend the road from 4 km to 5 km will have $4M extra costs, but will bring $1M extra benefits – i.e. the net **marginal disadvantage** is $3M. (This means an investment of $4M is required in order to get back $1M. That does not make good business sense!)
  - To extend the road from 5 km to 6 km will have $6M extra costs, but will bring $1M extra benefits – i.e. the net marginal disadvantage is $5M.
  - To extend the road from 6 km to 7 km will have $4M extra costs, but will bring $1M extra benefits – i.e. the net marginal disadvantage is $3M.
- From the marginal analysis it can be concluded that the road should not be extended beyond 4 km, since more resources will be used to build the fifth, sixth and seventh kilometres than what can be gained from doing it.

- Marginal analysis determines whether money spent on something will return more or less than the amount spent.
- The optimum level of spending is where the marginal benefit is zero; and the reasoning is:
  - As long as an extra $1 spent on something brings more than $1 of benefits, it is worthwhile to spend the $1.
  - When the stage is reached where an extra $1 spent returns less than $1 of benefits, the spending is no longer worthwhile.
  - The breakpoint between *worthwhile* and *not worthwhile* is where an extra $1 spent returns only an extra $1's benefits, i.e. where marginal cost equals marginal benefit.

2.6 DIRECT, INDIRECT AND OPPORTUNITY COST

- The real cost of any activity undertaken is not only measured in terms of its *direct cost*, but also in terms of *indirect cost* and *opportunity cost*.
- For example, to study, the direct cost is the price of books and study material; an indirect cost is the cost of lighting the student's work area; and an opportunity cost is the study time during which income could have been earned by means of a part-time job.
- Opportunity cost (HEYMANN & BLOOM 1990) is only applicable when an alternative really exists. If the student in the above example does not already have a part-time job or cannot get one, the opportunity cost is zero, because in this case the student's studies don't interfere with another income producing activity.
- Example:
  - The tuition fees for a certain management course are $500; and it requires 50 hours' work to study it.
  - To keep a 100 watt desk lamp on for 50 hours, requires 5 kilowatt-hours of electrical energy. At a cost of 20 cents per kilowatt-hour, this amounts to an indirect cost of $1. Say it costs $99 to rent a cubicle in a library where the student can study for 50 hours (excluding electricity costs). The total indirect cost is thus $100.
  - Instead of studying this course, the student could have done part-time work, earning $8 per hour. Instead of spending 50 hours on studying this course, the student could thus have earned $400 through part-time work.
  - The direct cost of the course is $500, the indirect cost is $100, and the opportunity cost is $400. The total cost for the course is therefore $1000.
  - Unless the student can gain more than $1000 by doing the course, it is not worthwhile. (That is apart from social benefits such as self-fulfilment.)
- The above example clearly shows that it is important to analyse all costs, and not only direct costs, when economic analyses are done.

2.7 PRODUCTION POSSIBILITIES LIMITATIONS

- The concept *production possibilities limitations* refers to the fact that production of one type of product must often be limited in order to allow production of another type of product.
- This is due to limited availability (scarcity) of resources for producing the different products – which can be a ***constraint*** in a design process.
- The concept is best illustrated by means of a simple example of a *dual product economy* - i.e. an economy where only two types of products are produced:
  - Say, with available resources, 1000 litres of milk (Product 1) can be produced per day.
  - The milk can be consumed fresh, or it can be used to make cheese (Product 2).
  - The more cheese is made, the less fresh milk is available.

- Some consumers will prefer to have only fresh milk, and no cheese; while others will prefer only cheese and no milk.
- Choices thus have to be made regarding what, how much, and for whom to produce – given the limited resources.

- This concept is very relevant in a production environment, and thus for engineers.

2.8 INFLATION

- *Inflation rate* can be defined as the rate at which the average value of money deteriorates over time (CORDEN 1986; HAHN 1985; BAILY & OKUN 1982).
- Inflation rate is not commonly calculated for individual products or services, but is calculated by using the combined prices of a typical basket of products and services consumed by the average household.
- A country's central bank or its statistical service will decide on the list of products and services to be included in the calculation.
- If the price of such a basket of products and services is P_1 now, while it cost P_0 a year ago, the annual inflation rate is: $INF = (P_1 - P_0)/P_0$.
- The two main types of inflation are:
  - "Demand pull inflation", which occurs when the demand for a specific product or service is higher than the supply thereof. Prices are then forced up, causing the product or service to cost more than what it used to cost.
  - "Cost push inflation", which occurs when input costs rise - e.g. due to higher labour wages, and thus forcing price rises in the production chain.
- Because of inflation, two types of prices (or costs, or incomes, etc.) can be specified:
  - *Real price*, which is the price in terms of a reference value (e.g. constant 1995 dollars).
  - *Nominal price*, which is the currently quoted price.
- When money is invested, the *real rate of return* (the return after taking the effect of inflation into account) is lower than the *nominal rate of return* (e.g. the interest rate offered by a bank when money is invested at the bank).
- These rates of return and inflation are related as follows:
  (1 + Nominal return) = (1 + Real return) (1 + Inflation).
- Example:
  - Assume a bank offers an interest rate of 12% per year, on money invested with them; while the inflation rate is 15% per year.
  - Real return = [(1 + Nominal return)/(1 + Inflation)] – 1
    = [(1+0,12)/(1+0,15)] – 1
    = -0,026
    = -2,6%.
  - This means that although interest is earned on the money in the bank, the initial sum invested

plus the interest earned on it, will have 2,6% less "buying power" at the end of the year, compared with its current buying power.

- Taking the effects of inflation into account is very important when economic decisions are made.

2.9 PRESENT AND FUTURE VALUES

- Attempts to make life easier in future can mean that fewer resources must be allocated for current consumption – i.e. current resources must be saved for later.
- Many people do it the other way round: by borrowing, some future resources are shifted back in time, and can thus be used earlier, e.g.:
  - After working for the next year, a person will have earned enough money to buy a car. However, he needs the car now.
  - He can go to a bank, and convince them to lend him enough money to buy the car now. The bank might do it if they are convinced that:
    - the person will have the money to pay them back after a year (i.e. the bank will take risk into account);
    - when they get their money back, it is not worth less than what they have lent him (i.e. they will take the effect of inflation into account); and
    - they will get some payment for the service which they offered by lending him money (i.e. they will charge interest).
- The total *market interest rate* charged on a loan is the rate of exchange between future and present resources, and depends on the risk envisaged by the lender, on the current inflation rate, and on the payment required for lending the money.
- Consider the following example:
  - Assume: a man wants to borrow $50000 from a bank to buy a car; inflation rate is 5% per year; and the bank wants a 7% "real return" on the loan.
  - When the bank gets their money back in a year's time they want it to have 7% more buying power than it has now. This is the "price" they charge for their service to help the man to buy his car now, and because there is risk involved for the bank.
  - In order to ensure the 7% higher buying power, the bank will charge a market interest rate (or nominal rate of return), which is a combination of their desired return (real rate of return) and the inflation rate: Nominal return = (1 + Real return)(1 + Inflation) – 1
    = [(1+0,07)/(1+0,05)] – 1
    = 0,1235
    = 12,35%.
  - The bank will thus charge 12,35% interest in order to offset the effects of inflation, and to have 7% more buying power when they receive their money back from the borrower.
- The *future value* (FV) of resources:
  - In nominal terms, FV equals its present value times (1+ market interest rate) – i.e.

FV_{nom} = PV x (1+ market interest rate).

- In real terms (considering the effects of inflation), equals its present value times (1+ real rate of return) – i.e. FV_{real} = PV x (1+ real rate of return).

- *Present value* (PV) is defined as the current value of resources which will be held in future (BIRRER & CARRICA 1990; ROBINSON & BARRY 1998).
- *Present wealth* is defined as the present value of all current and future resources.
- Reallocation of resources requires careful analysis of present and future values - and these are concepts which an engineer should understand very well.

3. BUDGETING

3.1 INTRODUCTION

- Budgeting is the process of estimating resource requirements before a project is started.
- A large part of an engineering manager's tasks include budgeting and allocation of resources.
- Budgeting is an important management tool, since it facilitates:
  - **Planning**, by encouraging careful consideration of options; and by providing target values to strive for.
  - **Co-ordination**, by showing whether one team's aspirations can be matched by the abilities of another team (e.g. matching the sales team's predictions with the production team's abilities); and by allocating resources (money, materials, machines and manpower) amongst different teams.
  - **Motivation**, by providing clear guidelines and expectations to individual departments; and by helping people to strive for their set goals.
  - **Control**, by quantifying a plan of action, and by providing benchmarks against which to measure actual performance.
- Strategic planning (planning an organisation's future or a project) must always precede budgeting; and following from such planning, is a budget as the numerical part of the plan.

3.2 ACCOUNTING NUMBERS VERSUS CASH FLOWS

- There are two types of numbers important in budgeting:
  - **Accounting numbers** in a budget reflect the anticipated values of transactions expected to take place. However, a transaction can take place now, while the payment for it might only follow later. The accounting numbers record the transaction when it happens, whether the payment is made simultaneously or not (RACHLIN & SWEENY 1996; TRACEY 1997; WAYNE 1999).
  - **Cash flow numbers** in a budget indicate the amounts of cash which are anticipated to flow

into or out of the business at specific times (LOSCALZO 1995; SIEGEL & SHIM 1992).

- A cash flow budget for a new project includes all changes expected in the cash flow if the new project is accepted.
- The only amounts of relevance to cash flow for a new project, are the changes or increments that are expected in the cash flows if the new project is accepted. Amounts which are not specifically due to the project under consideration should not be included in the project's cash flow budget.

3.3 COMPILING A CASH FLOW BUDGET

3.3.1 Introduction

- The budgeting process should start when the top manager issues a budget request to the next layer of managers.
- With the budget request, the top manager will typically include comments on aspects such as:
  - the business' performance in the current year;
  - reasons for differences between the previous budget and the current performance;
  - views on potential growth (both in demand for products and ability to produce it);
  - intended new products; and
  - relevant economic indicators.
- The relevant parts of the budget request should be rolled down to subsequent layers in the management hierarchy. Inputs must then be obtained from the lowest level, and aggregated to subsequent next higher levels, until an overall budget is obtained.
- It is useful to do a budget by means of a computerised spreadsheet, so that the effects of changes to estimates can be easily evaluated.
- The following steps can be used as a guideline for budgeting. These steps must be adapted to specific circumstances (ANGUS & GUNDERSEN 1997, LANIGAN 1992, and SCOTT & ROCHESTER 1987).

3.3.2 Step 1: Sales Budget

- Without sales, a business' other activities have no reason for existence. Therefore all budgeting relies on a sales budget, which starts with the estimated number of units (products or services) to be sold per period (e.g. per quarter or per month), and with the estimated unit price.
- It is important to remember that unless all sales are for cash, the cash flows will differ from the sales values. The cash flow per period equals sales made in previous periods, but which are only paid for now; plus cash sales made in this period.
- The following table shows an example of a sales budget (accounting numbers) and the corresponding sales cash flow budget for one year:

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Estimated number of units that will be sold	5000	5600	3400	6000	**20000**
Unit price [$]	75	75	80	85	
Estimated sales income [$]	375000	420000	272000	510000	**1577000**
Cash sales [$]	290000	350000	210000	398000	**1248000**
Payment expected in different quarters for sales made previously [$]	0	80000	63000	111000	**254000**
Estimated cash inflow from sales [$]	290000	430000	273000	509000	**1502000**

- This is assumed to be a new project, therefore there are no payments in quarter 1, for sales made previously.
- Conclusions that can be drawn from the above sales and cash flow budget include:
  - The number of units sold is expected to fall in quarter 3 and to rise again in quarter 4. It is important to determine whether the fall is due to the increased price, or whether it is a normal tendency. Analysis of so-called price elasticity (RYDELL 1983) should show whether it wouldn't perhaps be better to lower the price in the third quarter to ensure higher sales; and whether an even bigger price increase in quarter 4 wouldn't perhaps be viable. (Remember: the highest sales volume is not necessarily the goal, but the highest profit is.)
  - Payment for some sales is not expected soon after the sale. The total estimated cash inflow from sales is therefore less than the estimated sales itself, for the year. If the difference between these two numbers becomes too large, stricter credit control should be introduced.

3.3.3 Step 2: Production Budget

- A production budget (done in terms of number of products made, and not in monetary terms) is necessary to ensure that the estimated number of units sold can be met by the production department.
- (This step must be adapted if the business does not produce any products, but only buys stock for resale; or if the business only provides services.)
- The number of units to be produced depends on the number of units estimated to be sold, on the number of units that can be drawn from inventory, and on the number of units that must go into inventory, i.e.: *Units required = Sales budget + Planned closing inventory - Opening inventory*.
- The number of units that must go into inventory is normally calculated as a percentage of the next quarter's estimated sales, in order to provide for unforeseen production problems; but it can also be varied to smooth the production flow.
- Example of a production budget (derived from the sales budget in step 1):

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Estimated units sold	5000	5600	3400	6000	**20000**
Plus Units to inventory	560	340	1600	660	**660**
Minus Units from inventory	(0)	(560)	(340)	(1600)	**(0)**
Units to be produced	5560	5380	4660	5060	**20660**

- Notes:
  - All negative numbers, or numbers to be subtracted, are shown in parentheses.
  - In this example, production is smoothed by producing 1600 units for inventory in quarter 3.
  - Units to and from inventory, under *Total* reflect units drawn from inventory at the start of quarter 1 (0 units, since this is assumed to be a new project), and units going into inventory at the end of quarter 4 (660 units, since the project will continue beyond the current year).
  - It is clear that more units will be produced (20660) during the budget year, than what is estimated to be sold (20000). This is done in order to have some stock to carry over to the first quarter of the next year (e.g. to provide for possible future production problems).

3.3.4 Step 3: Input Cost Budget

- This step uses the estimated number of units to be produced (step 2) to estimate the cost of raw materials required for production, the quantity of materials to be bought, and the cash outflow due to the purchase of raw materials.
- *Raw material cost = Units to be produced x Material requirements per unit x Material price*.
- *Cost of materials bought = [Units of raw material required + Planned closing inventory of raw materials + Material losses - Opening inventory of raw materials] x Unit cost of raw materials.*
- *Cash outflow for raw material purchases = Previous quarter's creditors + New payments.*
- (This step should also be adapted if products are not produced, or if services are provided.)
- Example of an input cost budget (derived from the production budget in step 2):

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Units to be produced	5560	5380	4660	5060	**20660**
Raw materials per unit (e.g. m^2)	10	10	10	10	**10**
Total material requirement [m^2]	55600	53800	46600	50600	**206600**
Plus Material to inventory [m^2]	5380	4660	5060	6000	**6000**
Plus Material losses [m^2]	556	538	466	506	**2066**
Minus Material from inventory [m^2]	(0)	(5380)	(4660)	(5060)	**(0)**
Raw material to be purchased [m^2]	61536	53618	47466	52046	**214666**
Unit cost of raw material [$/$m^2$]	1,00	1,00	1,10	1,15	
Total raw material cost [$]	61536	53618	52212,60	59852,90	**227209,50**
Estimated payments to be made in different quarters, for materials:-					
Purchased before Quarter 1	0	0	0	0	**0**
Purchased in Quarter 1	21600	31088	8848	0	**61536**
Purchased in Quarter 2	0	33000	20618	0	**53618**
Purchased in Quarter 3	0	0	10000	20000	**30000**
Purchased in Quarter 4	0	0	0	19000	**19000**
Estimated cash outflow for raw material purchases [$]	21600	64088	39466	39000	**164154**

- Notes:
  - In this example, material losses are estimated to be 10% of material requirements. Limiting losses through careful management is essential, and can be a significant cost saver.
  - No payments will be made for materials bought before quarter 1, since this is a new project.
  - It is expected that some materials purchased in quarters 3 and 4 will only be paid for in the next year.
  - Normally, products will require different types of raw material, necessitating a more elaborate budget than the above example.

3.3.5 Step 4: Direct Labour Cost Budget

- Purchased raw materials must be converted to finished products, and that requires labour.
- The cash flow for labour matches the direct labour cost, because salaries are paid immediately.
- Example of a direct labour cost budget (derived from the production budget in step 2):

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Units to be produced	5560	5380	4660	5060	20660
Labour hours required per unit	2	2	2	2	2
Total labour hours required [hr]	11120	10760	9320	10120	41320
Unit cost of labour [$/hr]	10	10	11	11	
Total direct labour cost [$]	111200	107600	102520	111320	432640

3.3.6 Step 5: Fixed Assets Budget

- When fixed assets are bought or sold, cash flow is influenced only when payments are made.
- Depreciation of fixed assets is the amount by which its value is assumed to decrease because of it being used. This has an influence on accounting numbers, but not on cash flow.
- Example of a fixed assets budget:

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Fixed asset opening balance [$]	0	95000	327750	221112	**0**
Plus Planned assets bought [$]	100000	250000	0	0	**350000**
Minus Planned assets sold [$]	0	0	(95000)	0	**(95000)**
Minus Depreciation [$] (assumed 5% per quarter)	(5000)	(17250)	(11638)	(11055)	**(44943)**
Fixed asset closing balance [$]	95000	327750	221112	210057	**210057**
Estimated payments to be made in different quarters, for assets:-					
Purchased before Quarter 1	0	0	0	0	**0**
Purchased in Quarter 1	0	100000	0	0	**100000**
Purchased in Quarter 2	0	25000	25000	200000	**250000**
Purchased in Quarter 3	0	0	0	0	**0**
Purchased in Quarter 4	0	0	0	0	**0**
Cash outflow for fixed assets bought [$]	0	125000	25000	200000	**350000**
Estimated payments to be received in different quarters, for assets:-					
Sold before Quarter 1	0	0	0	0	**0**

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Sold in Quarter 1	0	0	0	0	**0**
Sold in Quarter 2	0	0	0	0	**0**
Sold in Quarter 3	0	0	0	95000	**95000**
Sold in Quarter 4	0	0	0	0	**0**
Cash inflow from fixed assets sold [$]	0	0	0	95000	**95000**
Net cash outflow for fixed assets [$]	0	125000	25000	105000	**255000**

3.3.7 Step 6: Manufacturing Overhead Budget

- Manufacturing overheads refer to indirect costs incurred as a direct consequence of the manufacturing operations; and there are two types of manufacturing overhead costs:
  - **Variable manufacturing overheads**, which varies as production numbers vary – e.g. electricity consumption in the manufacturing plant. One way to overcome the difficulty of estimating variable overheads, is to assume that it is proportional to the direct labour cost (estimated in step 4).
  - **Fixed manufacturing overheads** (e.g. factory rent, depreciation on manufacturing equipment, etc.), which is not proportional to the level of production output.
- Since depreciation is not a cash flow, but an accounting number, it must be subtracted from the manufacturing overhead budget in order to estimate manufacturing cash flow overheads.
- (When more than one project or business unit generates overhead costs, these can be assigned to the different cost centres according to an *absorption rate* reflecting the specific cost centre's contribution to the overhead costs relative to the total overhead costs. One way to define an appropriate absorption rate is to use the ratio of the specific cost centre's direct labour costs relative to the total business' direct labour costs.)
- Example of an overhead cost budget (derived from the direct labour cost budget in step 4):

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Estimated direct labour cost [$]	111200	107600	102520	111320	**432640**
Factor reflecting variable manufacturing overhead relative to direct labour cost	0,45	0,45	0,5	0,5	
Estimated variable manufacturing overhead cost [$]	50040	48420	51260	55660	**205380**
Estimated fixed manufacturing overhead cost [$]	10760	15380	11000	11000	**48140**
Estimated total manufacturing overhead cost [$]	60800	63800	62260	66660	**253520**
Minus Depreciation [$] (non-cash part of fixed manufacturing overhead – from step 5)	(5000)	(17250)	(11638)	(11055)	**(44943)**
Estimated manufacturing overhead cash outflow [$]	55800	46550	50622	55605	**208577**

3.3.8 Step 7: Operating Cost Budget

- Operating costs refer to costs incurred before and after the manufacturing stage, and typically include:
  - **Variable costs**, which can normally be budgeted as a percentage of the sales budget, such as packaging materials, specialised advertising, specialised research and development, electricity and water consumption, etc.
  - **Fixed costs**, such as salaries for managers and support staff, general advertising, insurance, general research and development, rates and taxes, telephone, basic electricity and water charges, etc.
- Example of an operating cost budget (derived from the sales budget in step 1):

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Estimated sales income [$]	375000	420000	272000	510000	**1577000**
Product specific advertising (2,5% of sales)	9375	10500	6800	12750	**39425**
Product specific R&D (2,5% of sales)	9375	10500	6800	12750	**39425**
Packaging (2% of sales)	7500	8400	5440	10200	**31540**
Variable office electricity and water (1% of sales)	3750	4200	2720	5100	**15770**
Salaries (managers and office staff)	20000	20000	22000	22000	**84000**
Basic electricity and water	500	500	550	550	**2100**
General advertising	3500	3500	3850	3850	**14700**
General R&D	4000	4000	4400	4400	**16800**
Total operating cost	58000	61600	52560	71600	**243760**

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Estimated payments to be made in different quarters, for operating costs:-					
Incurred before Quarter 1	0	0	0	0	**0**
Incurred during Quarter 1	51500	6500	0	0	**58000**
Incurred during Quarter 2	0	47600	13000	1000	**61600**
Incurred during Quarter 3	0	2000	45600	3200	**50800**
Incurred during Quarter 4	0	0	0	65200	**65200**
Cash outflow for operating costs [$]	51500	56100	58600	69400	**235600**

3.3.9 Step 8: Overall Cash Flow Budget

- In this step, all the previous steps' cash flow estimates are combined in order to estimate the change in the organisation's cash balance.
- Example of an overall cash flow budget:

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
Cash inflow from sales [$] – step 1	290000	430000	273000	509000	**1502000**
Cash inflow from fixed assets sold [$] – step 5	0	0	0	95000	**95000**
Estimated total cash inflows [$]	290000	430000	273000	604000	**1597000**
Cash outflow for raw material purchases [$] – step 3	21600	64088	39466	39000	**164154**
Total direct labour cost [$] – step 4	111200	107600	102520	111320	**432640**
Cash outflow for fixed assets bought [$] – step 5	0	125000	25000	200000	**350000**
Overhead cash outflow [$] – step 6	55800	46550	50622	55605	**208577**
Cash outflow for operating costs [$] – step 7	51500	56100	58600	69400	**235600**
Estimated total cash outflows [$]	240100	399338	276208	475325	**1390971**
Opening cash balance [$]	0	49900	80562	77354	**0**
Plus Cash inflows [$]	290000	430000	273000	604000	**1597000**
Minus Cash outflows [$]	(240100)	(399338)	(276208)	(475325)	**(1390971)**
Closing cash balance [$]	49900	80562	77354	206029	**206029**

- Although *cash outflows* exceed *cash inflows* in quarter 3, a positive cash flow is maintained for the year (i.e. the yearly cash inflows exceed the yearly cash outflows); and this is always the desired situation.
- The cash accumulated during the year can be spent on expansion in future, e.g. buying more equipment, or more research and development, or more advertising, etc.

3.4 OTHER BUDGETS

- Various other budgets can also be compiled, e.g.:
  - **Profit and loss budget**, which estimates gross profit (difference between sales revenue and direct input costs); net profit before tax (gross profit minus fixed costs); and net profit after tax.
  - **Inventory budget**, which estimates stock levels of raw materials and of finished products.
  - **Balance sheet budget**, which estimates assets, liabilities and shareholders' equity.
  - **Maintenance budget**, which estimates resources required for plant maintenance for example.
- These budgets are, however, beyond the scope of this module.
- It is very important to realise that the above budgeting procedure must always be tailored to suit specific requirements.

3.5 REASONS FOR NOT BUDGETING PROPERLY

- Budgeting is such an important part of planning and control, that it cannot be neglected.

- However, despite its importance as a management tool, budgeting is often neglected or not done at all in many organisations. Typical reasons for this include:
  - Budgeting can be **difficult** because of the many interrelations between different amounts, and because it is based on estimates. However, by using the guidelines in section 3.3 above, many of the difficulties can be overcome.
  - Budgeting is **time consuming** and requires many inputs from different people.
  - **Lack of top management commitment**. Unless top management is committed to budget accurately, and to stay within the budget, the lower level managers and the employees cannot be expected to do so.
  - **Allocation of indirect costs**. It is often difficult to decide on how to assign overhead and indirect costs to different cost centres.
  - **Moving goal posts**. Circumstances change, causing original assumptions on which a budget was based, to become invalid. Unless changing circumstances are taken into account, the budget becomes invalid, and is then perceived as a waste of time.
  - **Lack of experience**. Budgeting becomes more accurate the more experience is gained by the estimators.
  - **Lack of accurate historical financial data**. Budgeting becomes more accurate the more the estimators can compare their estimates with the actually attained financial results.
  - **Insufficient time**. Budgeting is a time consuming process, which requires many iterations. Unless enough time is made available, an accurate budget cannot be compiled.

4. PROJECT INVESTMENT DECISIONS

4.1 INTRODUCTION

- Before a business invests money in a new project, it must make sure that the investment is worthwhile.
- Even if the *cash flow budget* and the *profit and loss budget* look good, the effects of inflation must still be evaluated.
- Several evaluation techniques (e.g. ROBINSON & BARRY 1998) can be used for this purpose, and some of the most prominent ones are discussed in this chapter.

4.2 INVESTMENT EVALUATION TECHNIQUES

4.2.1 Internal Rate of Return

- *Internal rate of return* (IRR) indicates the equivalent interest rate earned from an investment.
- IRR is calculated as follows: IRR = CF_1/CF_0 - 1; where

- CF_0 is the initial amount invested; and
- CF_1 is the amount received back at the end of the investment (e.g. after one year).

- IRR must be more than the inflation rate (INF), otherwise the future buying power of the money received back from the investment will be less than its current buying power.
- Furthermore, IRR must be more than the interest rate which can be earned by keeping the money in the bank, otherwise it is better to keep the money in the bank.
- Consider the following investment examples (all projects which require a one year investment):

	Project 1	**Project 2**	**Project 3**	**Project 4**
Initial cash outlay (CF_0) [$]	100000	200000	300000	3000
Cash inflow after 1 year (CF_1) [$]	110000	250000	364550	5000
Inflation rate per year (INF)	0,15	0,15	0,15	0,15
Bank interest rate per year	0,23	0,23	0,23	0,23
Internal Rate of Return (IRR)	0,10	0,25	0,22	0,67

- Evaluation of the four investment options:
  - It is immediately obvious that the internal rate of return (IRR) of Project 1 is lower than the inflation rate, making it an undesirable investment.
  - Project 2 has an IRR that is more than the inflation rate and the bank interest rate – making this a good potential investment.
  - Although the IRR of Project 3 is higher than the inflation rate, it is lower than the bank interest rate, making it better to rather invest this money with a bank than in this project.
  - Since Project 4 has a very high IRR, it can erroneously be concluded that this is the best option. However, with this project only a small investment can be made, limiting the return potential.
- IRR is useful to evaluate individual investments, but not necessarily for comparing different investment options, since the investment with the highest IRR is not necessarily the best investment.
- For investments covering a number of time periods (e.g. many years) with varying cash in- and outflows per period, an IRR can be calculated for each period.

4.2.2 Net Present Value

- Net present value (NPV) is used to describe an investment in terms of the amount of wealth increase created by the investment; and this technique is used to overcome the limitations of internal rate of return (IRR) calculations.
- NPV = (present value of cash inflows) - (present value of cash outflows).
- For an investment with a single cash outflow CF_0, made now; and a single cash inflow CF_1, received one period (e.g. one year) later, the net present value is: $NPV = CF_1/(1+INF) – CF_0$; where “INF” is the inflation rate for the period of the investment.
- If NPV is negative, it is a poor investment, since the buying power of the money received back at the end of the investment, will be lower than that of the money now put into the investment.
- When a choice must be made amongst different investment options, the one with the highest

NPV is chosen.

- NPV is the most useful method to evaluate single investments, and to compare different investment options.
- Consider the following investment examples (all projects which require a one year investment):

	Project 1	Project 2	Project 3	Project 4
Initial cash outlay (CF_0) [$]	100000	200000	300000	3000
Cash inflow after 1 year (CF_1) [$]	110000	250000	364550	5000
Inflation rate per year (INF)	0,15	0,15	0,15	0,15
Net Present Value (NPV) [$]	-4347,83	17391,30	17000	1347,83

- Evaluation of the four investment options:
  - Project 1: Although the amount received back after one year (CF_1) is more than the amount invested initially (CF_0), this is not a good project, since the high inflation rate (INF) causes a negative net present value (NPV). That means that the buying power of the amount received back from the project after one year, will be less than the buying power of the amount invested.
  - Project 2: This project has the highest net present value (NPV), making it the best of the four options.
  - Project 3: Even though this project's amount received back after one year (CF_1) is more than that of Project 2, this option requires a larger initial investment (CF_0). This option has the second highest net present value (NPV), making it the second best of the four options.
  - Project 4: Although the IRR of this option is the largest, only a small investment is possible. Therefore only a small NPV is possible, which makes this option only the third best one.

4.2.3 Payback Period

- *Payback period* is defined as the number of periods required until a project's cash flows accumulate positively to equal the initial outlay - i.e. it is a measure of the time required to recover a project's original investment.
- With this method, the calculated payback period is compared with the desired break-even time. If the calculated payback period is less than the investor's desired period, the investment is made.
- The effect of risk can be incorporated by decreasing the desired payback period - e.g. it can be decided that a high risk investment will be made if the payback period is only one month. The investor then has only one month in which to worry about the investment.
- In its normal form, this method does not discount cash flows to present value, thus giving equal weight to future cash flows, irrespective of inflation rates. (This is a very serious limitation when high inflation rates occur.)
- Consider the following project over four years (assume zero inflation rate):

	Year 1	Year 2	Year 3	Year 4
Cash outlay [$]	150000	130000	30000	10000
Cash inflow [$]	110000	155000	42000	50000
Net cash flow	-40000	25000	12000	40000
Accumulated cash flow	-40000	-15000	-3000	37000

- It is clear that this project's accumulated cash flow will become positive somewhere in year 4. Therefore the payback period is between three and four years.
- The main reasons why this technique is used are its simplicity and its ease of computation.
- If inflation is a significant factor, and has to be taken into account, the computations become more complex, but also more accurate. With modern computers, the more complex calculations are not really an issue anymore – and this is illustrated in section 4.2.4 below.

4.2.4 Benefit-Cost Ratio

- Benefit-cost ratio of an investment is the ratio of the present values of cash inflows and cash outflows.
- BCR = PV_{in} / PV_{out}, where:
  - PV_{in} = Σ $Inflows_t$ / $(1 + INF)^t$, for t = 1 to n.
  - PV_{out} = Σ $Outflows_t$ / $(1 + INF)^{t-1}$, for t = 1 to n.
  - $Inflows_t$ = cash inflows received at the end of period t.
  - $Outflows_t$ = cash outflows made at the start of period t.
  - INF = inflation rate (assumed constant over all periods).
  - n = lifetime (number of periods) of the investment.
- An investment can be accepted only if BCR > 1. (That also implies that NPV > 0, because NPV = PV_{in} - PV_{out}.)
- BCR is high for investments with a large difference between inflow and outflow, but not necessarily for investments with the largest actual differences between cash inflows and cash outflows.
- Therefore BCR is more suitable to evaluate a single investment, instead of comparing different investment options.
- Consider the following investment example for a project over four years:

	Year 1	**Year 2**	**Year 3**	**Year 4**
Cash outlay [$]	150000	130000	30000	10000
Cash inflow [$]	110000	155000	42000	50000
Inflation rate per year (INF)	0,15	0,15	0,15	0,15

- PV_{in} = (110000/1,15) + (155000/$1,15^2$) + (42000/$1,15^3$) + (50000/$1,15^4$) = 269058.
- PV_{out} = 150000 + (130000/1,15) + (30000/$1,15^2$) + (10000/$1,15^3$) = 285728.
- BCR = PV_{in} / PV_{out} = 269058/285728 = 0,94.
- It is clear that BCR < 1, which is due to the high inflation rate.
- This is definitely not a good investment, since the present value of the cash outflows is more than the present value of the cash inflows.
- When the above analysis is compared with the payback calculations for the same project (where zero inflation rate was assumed - refer to section 4.2.3 above) it is clear that inflation can significantly influence the viability of an investment.

4.2.5 Return on Investment

- The *return on investment* method divides the expected accounting profits per period, by the net book value (i.e. depreciated value) of the investment's assets for that period.
- The result is then compared with some standard - e.g. the business' history or an industry norm.
- The main reason for using this technique stems from the outdated habit of judging an investment by only looking at its accounting profits.
- Consider the following investment example for a project over four years:

	Year 1	**Year 2**	**Year 3**	**Year 4**
ixed asset opening balance [$]	0	95000	327750	221112
Plus Assets bought [$]	100000	250000	0	0
Minus Assets sold [$]	0	0	(95000)	0
Minus Depreciation [$] (assumed 5% per year)	(5000)	(17250)	(11638)	(11055)
Fixed asset book value *(B)* [$]	95000	327750	221112	210057
Accounting profit *(A)* [$]	21000	67000	44000	49000
Return on Investment *(A ÷ B)* [%]	22,1	20,5	19,9	23,3

- The major disadvantage of this method is that it uses accounting numbers instead of cash flows, which can give a distorted picture.
- For example, the assets' book value might be lower than their resale value. By selling the assets and investing the money elsewhere might produce an even better return on investment; and this is not clear from the accounting numbers.

4.3 CAPITAL RATIONING

- Any business is subject to constraints, one of which is the limited availability of money for investment in new projects.
- Capital rationing techniques are a set of methods for choosing the combination of investments which will maximise shareholder wealth.
- Example:
  - A business has $10000 available for investment; and there are three possible projects:
    - Project A: initial investment of $2000, and should return $2730 after one year.
    - Project B: initial investment of $4000, and should return $5376 after one year.
    - Project C: initial investment of $10000, and should return $12327 after a year.
  - Assume the annual inflation rate is 5%; and the bank interest rate is 7,5%.
  - The question is which of the following is the best investment option:
    - Option 1: Invest $10000 in the bank.
    - Option 2: Invest $2000 in Project A, and $8000 in the bank.
    - Option 3: Invest $4000 in Project B, and $6000 in the bank.
    - Option 4: Invest $2000 in Project A, $4000 in Project B, and $4000 in the bank.
    - Option 5: Invest $10000 in Project C.

- In order to compare the different investment options, their net present values must be calculated, e.g.:

Option	NPV of Project Investments	NPV of Bank Investment	Total NPV
1	0	10000[(1,075/1,05)- 1] = $238	$238
2	(2730/1,05) - 2000 = $600	8000[(1,075/1,05) - 1] = $190	$790
3	(5376/1,05) - 4000 = $1120	6000[(1,075/1,05) - 1] = $143	$1263
4	$600 + $1120 = $1720	4000[(1,075/1,05) - 1] = $95	$1815
5	(12327/1,05) - 10000 = $1740	0	$1740

- Option 4 ($2000 in Project A, $4000 in Project B, and $4000 in the bank) is the best one, since it has the highest total net present value (NPV).

- This method can become very exhaustive when many projects must be considered; and when investments are made over more than one year.
- However, computerised techniques, such as linear programming (THIE 1988) can be very useful for solving such problems.

4.4 RISK AND BUSINESS INVESTMENT DECISIONS

- Investments can be risky, since investment outcomes are always uncertain to some extent.
- Investment diversification is a technique used to reduce investment risk.
- However, in general, potential income is proportional to the risk taken.
- Therefore, capital suppliers require higher rates of return for bearing higher risk.
- If risk is totally avoided, the chances of increasing wealth are very small.

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6. SELF-ASSESSMENT

6.1 TRUE / FALSE QUESTIONS

Indicate which of the following statements are TRUE and which are FALSE.

1. Scarcity of resources is of no concern to economists.
2. *Production products / services* are produced for use by end users or consumers.
3. *Engineering economics* is not guided by the basic economic principles applying to any type of products and services.

4. In *centrally planned economies* a small group of people decides on the allocation of resources.
5. Less than 25% of the world's production comes from predominantly market economies.
6. It is important to use the minimum resources for production of any products or services - otherwise scarce resources are wasted.
7. *Marginal analysis* is a theoretical technique with little practical value, and therefore it is always better to use unit cost calculations rather than marginal analysis.
8. The real cost of any activity undertaken is only measured in terms of its *direct cost.*
9. *Inflation rate* ensures that the buying power of money remains constant over time.
10. Resources can be reallocated over time, through lending and borrowing.
11. Budgeting is the process of recording resource usage after completion of a project.
12. Cash flow budgets anticipate the amounts of cash which will actually flow into or out of a business, at specific times.
13. Most budgeting for a business relies on a sales budget.
14. A raw materials budget is necessary to ensure that sales can be met by the production department.
15. When fixed assets are bought or sold, it influences cash flow when the assets are paid for.
16. Negative NPV indicates a poor investment.
17. NPV is not useful to compare different investment options.
18. IRR is not ideal to compare different investment options.
19. Payback period is the number of periods required until a project's cash flows accumulate positively to equal the initial outlay.
20. If an investment's benefit-cost ratio exceeds 1, it does not necessarily imply that its net present value is positive.

6.2 MULTIPLE CHOICE QUESTIONS

Choose the one correct answer for each of the following questions:

1. Resources are best defined as:
   a. Elements such as water, soil and minerals.
   b. Anything that helps to produce products and services wanted by people.
   c. Manpower.
   d. None of the above.
2. Examples of *consumer products and services* are:
   a. Cake baked by the local bakery.
   b. A radio news bulletin.
   c. A car produced for private use by a family.
   d. All the above.
3. An example of *production products or services* are:
   a. A machine made for use in a factory.
   b. Food for factory workers.

c. Television shows.

d. All the above.

4. Which of the following economic systems rely primarily on the forces of demand and supply?

a. Centrally planned economies.

b. Capitalist (market) economies.

c. Traditional economies.

d. All the above.

5. "The market" can best be defined as places where:

a. Consumers and producers are brought together.

b. Prices are determined.

c. Exchanges of products and services take place.

d. All the above.

6. The following are types of efficiency of resource utilisation:

a. Engineering efficiency.

b. Economic efficiency

c. Marginal efficiency.

d. Both (a) and (b).

7. An example of direct cost for producing wheat is:

a. The cost of food for the farmer.

b. The cost of seed to plant.

c. Both (a) and (b).

d. None of the above.

8. Opportunity cost is only applicable when:

a. Students study.

b. An alternative really exists.

c. When one activity interferes with another income producing activity.

d. Both (b) and (c).

9. *Inflation rate* is:

a. The rate at which the average value of money deteriorates over time.

b. Is commonly calculated for individual products or services.

c. Is calculated by using the prices obtained in food stores.

d. Is not relevant for engineering managers.

10. *Real rate of return* is:

a. The return on an investment after taking the effect of inflation into account.

b. Lower than the *nominal rate of return*.

c. Calculated from (1 + Real return) = (1 + Nominal return) / (1 + Inflation).

d. All the above.

11. There is a difference between accounting numbers and cash flows, because:

a. Accountants tend to be too optimistic.

b. Accounting numbers reflect transactions whether payment has taken place or not.

c. Cash flows indicate the actual inflow and outflow of cash.

d. Both (b) and (c).

12. Normally some products produced go into inventory, because:
    a. Over optimistic sales forecasts are always made.
    b. Too many products are always produced.
    c. The sales department can never sell all the products produced.
    d. This practice provides for unforeseen production problems in later periods.
13. Direct labour cost can be calculated from:
    a. Number of units required x Hours available x Labour cost per hour.
    b. Number of units required x Hours per unit x Labour cost per hour.
    c. Number of units required x Number of labourers.
    d. None of the above.
14. Depreciation of fixed assets is:
    a. A decrease in the asset's value because of poor maintenance.
    b. Difference between the asset's purchase price and the price of a similar new asset.
    c. The amount by which its value is assumed to decrease because of the asset being used.
    d. Only a theoretical concept.
15. Salaries for managers and support staff are normally:
    a. A variable cost (i.e. proportional to production levels).
    b. A fixed cost.
    c. An unnecessary cost.
    d. An opportunity cost.
16. The following are examples of techniques for investment analysis:
    a. Net present value, Nominal values, Budgeting, Internal rate of return, and Planning.
    b. Net present value, Depreciation, Cost-benefit ratio, and Return on investment.
    c. Net present value, Internal rate of return, Cost-benefit ratio, and Inflation.
    d. Net present value, Internal rate of return, Cost-benefit ratio, and Payback period.
17. Disadvantages of the payback method include:
    a. It ignores all cash flows beyond the minimum acceptable payback period.
    b. It discounts cash flows to present value.
    c. It considers the effects of inflation.
    d. All the above.
18. In case of capital rationing, the best strategy is:
    a. To make as many small investments as possible.
    b. To invest in only one place.
    c. To evaluate NPV of different options, and then choose the combination with the highest NPV.
    d. All the above.
19. Investments can be risky, since:
    a. There are many dishonest investors.
    b. It is totally impossible to asses any of the risk involved in an investment, in advance.

c. Investment outcomes are always uncertain to some extent.
d. None of the above.

20. Investment diversification is a technique used to:
    a. Reduce investment risk.
    b. To create work.
    c. To cover non-profit organisations against the effects of inflation.
    d. All the above.

6.3 ESSAY QUESTIONS

Write an essay of 300 to 400 words on one of the following topics. Do not merely copy the course notes, but write the essay **in your own words** such that your understanding of the topic becomes clear.

1. Discuss the concept "scarcity of resources" and its influence on a typical engineering manager.
2. Discuss how you would approach the task of compiling a cash flow budget for a manufacturing business.
3. Discuss the differences between "accounting budgets" and "cash flow budgets".
4. Discuss different techniques for the analysis of a single investment, and for comparing different investment options.

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