



0 • Exam Map

COURSE DATA · FINAL MODE 2026

Assignments Midterm 40% Final 40%

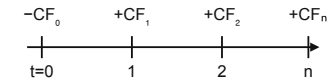
Published weights total 100%; Final Test covers all topics.

“Open book but only hard copies.” (QF5213 course page (final test mode, 2026)) · “Exemplify. Block internet. Open book.” (QF5213 course page (final test mode, 2026))

COMPONENT	WEIGHT	FORMAT
Group Assignments	20%	three submissions
Midterm Test	40%	2 h · MCQ · through Bonds
Final Test	40%	2 h · MCQ · all topics

1 • Date Every Cash Flow

C2 · CORE SETUP



Sign first, date second, formula third.

SINGLE SUM

$FV_t = PV(1+r)^t$

$PV = FV_t / (1+r)^t$

UNEVEN STREAM

$PV = \sum CF_t / (1+r)^t$

Exam decision: moving right compounds; moving left discounts. For m compounding periods per year use **r/m and mt together**. Continuous: $FV = PV \cdot e^{rt}$.

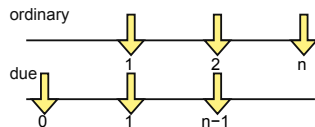
PROMPT	SET-UP	CHECK
amount due later	discount to t=0	PV<FV for r>0
deposit today	compound to target date	FV>PV for r>0
uneven stream	PV every signed flow separately	all terms share one date
monthly/semiannual	divide rate; multiply periods	units match

Why time has value: current money can earn interest, inflation reduces future purchasing power, and promised payment may fail. Simple interest adds the same dollar amount each period; compound interest earns on accumulated interest. More frequent positive compounding raises FV but lowers the PV needed to reach a fixed future amount.

Independent check: value an uneven stream at t=0, then compound that total to the final date. It must match compounding each individual flow to that date. A one-period counting error breaks this equality.

GOAL AND CONTROL · C1

2 • Level Streams C3 · FORMULA CHOICE



Due shifts every payment one period earlier; multiply the ordinary value by 1+r.

ORDINARY ANNUITY

$PV = C[1 - (1+r)^{-n}] / r$

$FV = C[(1+r)^n - 1] / r$

ANNUITY DUE

PV or FV = ordinary value $\times (1+r)$

PERPETUITIES

level: $PV = C / r$

growing: $PV = C_1 / (r-g)$, requiring $g < r$

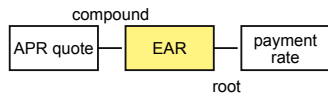
Trigger words: “end”, “next month/year” → ordinary; “today”, “immediately”, “beginning” → due. A deferred perpetuity is first valued **one period before its first payment**, then discounted to today.

UNKNOWN	REARRANGE / INTERPRETATION
loan payment C	$C = PV \div \text{annuity factor}$
savings target	$C = FV \div \text{FV annuity factor}$
balance after k payments	PV at k of remaining instalments
due stream	ordinary value $\times (1+r)$

Amortisation: each instalment splits into interest = opening balance $\times$ period rate and principal = payment - interest; new balance = old balance - principal. Early instalments carry more interest because the balance is larger.

3 • Make Rate Match Payment

C3 · APR/EAR



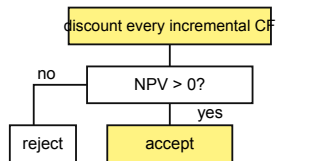
Different clocks? Convert quote → EAR → rate per payment period.

$EAR = (1 + APR/m)^m - 1$
payment-period $r = (1+EAR)^{1/k} - 1$

BASIS	WHAT EARNS INTEREST	IMPLICATION
Reducing balance	balance still owed	quote and true period rate align
Flat	original principal throughout	true cost much higher
Annual reset	balance reset yearly	between the two

4 • Appraisal Rule Hierarchy

C4 · DECISION MARKS



NPV is the value rule; the other measures diagnose return, speed or scarcity.

NET PRESENT VALUE

$NPV = CF_0 + \sum_{t=1}^n CF_t / (1+r)^t$

accept independent project if $NPV > 0$

RETURN AND SCARCITY

IRR solves $NPV=0$; accept

conventional project if $IRR > r$

$PI = PV(\text{inflows}) / \text{initial outlay}$;

accept if $PI > 1$

METHOD	USE	FAILURE MODE
NPV	dollars of value	forecast/rate quality
IRR	percentage return	ranking conflict; multiple roots
PI	benefit per \$ under a cap	not the unconstrained rank
Payback	liquidity speed	ignores later CFs; simple form ignores TVM

Ranking conflict: for mutually exclusive projects, use the **higher NPV**. Find crossover as IRR of year-by-year differences. More than one sign change can produce multiple IRRs: report the range where $NPV > 0$. Unequal lives, if repeatable: common life or $EAA = NPV/\text{annuity factor}$.

WHAT EACH EDGE CASE ASKS

Independent projects: accept every $NPV > 0$ project if funds are available. **Mutually exclusive**: selecting one removes the other, so dollar value wins. **Capital rationing**: rank benefit per constrained dollar with PI, then choose the feasible bundle that maximises total NPV. **Unequal lives**: use EAA /common life only if repetition is realistic; otherwise compare ordinary NPVs.

HURDLE FROM FINANCING MIX

$WACC = w_d r_d(1-T) + w_e r_e$

Multiple-IRR diagnostic: -10,000, +26,000, -16,500 changes sign twice and has IRRs of 10% and 50%; NPV is positive only between them (at 25%, +240). State the acceptable rate band, not one misleading IRR.

Payback interpolation: full years before recovery + unrecovered amount at start of recovery year / that year's cash flow. Discounted payback uses present values first. Both ignore every flow after recovery and depend on an arbitrary cutoff.

5 • Build the Project Cash Flow

C5 · CLASSIFICATION CORE

INITIAL	OPERATING	TERMINAL
asset + install + ΔNWC = outflow	after-tax margin + dep. shield each period	OCF + SV + tax effect + NWC return
with project – without project		

Sort first; discount only the resulting net flow in each dated block.

OPERATING CASH FLOW

$OCF = (\text{Revenue} - \text{cash costs})(1-T) + T \cdot \text{Dep}$

AFTER-TAX SALVAGE

$ATSV = SV - T(SV - BV)$

ITEM	RULE
Sunk cost	exclude: occurs either way
Opportunity cost	include best forgone use
Erosion / complements	include induced loss / gain
Allocated overhead	only the incremental part
Interest / dividends	exclude: WACC already prices financing
Net working capital	outflow when tied up; inflow on release
Depreciation	not cash; include its tax shield

Exam test: would this cash move if the project were rejected? If no, include it; if yes anyway, exclude it; if only part changes, include only that increment.

Below-book salvage makes $(SV - BV)$ negative, so the formula adds a **tax credit**.

THREE-BLOCK ASSEMBLY

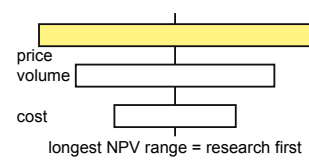
$CF_0 = -(\text{asset price} + \text{freight} + \text{installation}) - \Delta NWC_0$
 $CF_t = OCF_t - \text{later capital spending} - \Delta NWC_t$
 CF_n adds $ATSV$ + release of NWC

Two equivalent OCF routes: from cash margin, use $(R - \text{cash costs})(1-T) + T \cdot \text{Dep}$; from operating profit after tax, add depreciation back. Do not add both the full depreciation and its shield. Credit sales enter cash flow when collection occurs, not merely when accounting revenue is booked.

Classification traps: research paid last year is sunk even if it feels project-related; rent forgone on owned space is an opportunity cost only if an alternative tenant/use exists; cannibalised contribution is charged only when the launch causes it; extra complementary sales are credited; a shared overhead allocation is excluded unless total firm cash overhead changes.

6 • Risk Around the Base NPV

C6 · ANALYSIS



Sensitivity moves one input at a time; scenarios move linked inputs together.

NPV response ratio = $\Delta NPV / \Delta \text{input}$

BREAK-EVEN VOLUME

Accounting $Q = (\text{fixed cost} + \text{depreciation}) / (\text{price} - \text{variable cost})$
 $EAC = \text{initial outlay} / \text{annuity factor}$

Financial $Q = [EAC + \text{fixed}(1-T) - T \cdot \text{Dep}] / [(\text{price} - \text{variable})(1-T)]$

Accounting break-even sets profit=0; tax cancels.

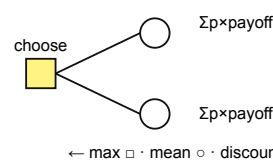
Financial break-even sets $NPV=0$ and charges the required return, so it is higher whenever $r > 0$. Compare expected volume with the correct line and state the safety margin.

TOOL	CHANGE	ANSWER
Sensitivity	one input; rest fixed	which forecast drives NPV?
Scenario	linked inputs together	what does a coherent state do?
Break-even	solve sales/volume	where does profit or NPV reach zero?

Course plant: price \$2,600 → \$2,450 moves NPV \$15.77m → -\$10.31m; response = 28.7% of NPV per 1% price change. Research the longest bar first.

7 • Trees & Flexibility

C7 · FOLD BACK



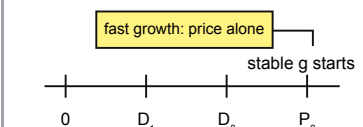
Squares are decisions; circles are chance. Never average a choice.

option value = NPV with flexibility - NPV without flexibility

Delay	compare every launch-date NPV after discounting it to today
Abandon	take salvage when it beats continuing
Expand	scale a successful branch without scaling the failed one

8 • Common Stock

C8 · VALUATION



Forecast early dividends; terminal price uses the first stable-growth dividend.

required return: $r_s = r_f + \beta(\text{market risk premium})$
zero growth: $P_0 = D_1 / r_s$
constant growth: $P_0 = D_1 / (r_s - g)$, $g < r_s$
two-stage: $P_0 = \sum D_t / (1+r_s)^t + P_n / (1+r_s)^n$
 $P_n = D_{n+1} / (r_s - g)$

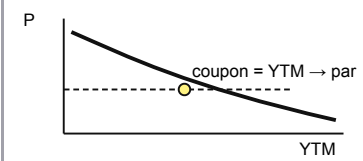
METHOD	USE / BRIDGE
P/E	positive, meaningful earnings
P/S	loss-making firm; revenue positive
P/B	market price against net assets
EV/EBITDA	enterprise value → + excess cash - debt → equity; ÷ shares
Free cash flow	discount at WACC → same enterprise-to-equity bridge

Trap: the growth model uses **D_s**, not **D₀**. A takeover premium over the last trade is not proof of fairness; compare with an independent intrinsic value.

Price directions: higher risk-free rate, beta or market premium raises r_s and lowers price; stronger dividends or sustainable growth raises price. Never force $g \geq r_s$ into the constant-growth formula.

9 • Bonds

C9 · PRICING/YIELDS



Price and required yield move oppositely; the curve is convex.

Price = $C[1 - (1+y)^{-n}] / y + F / (1+y)^n$
current yield = annual coupon / price

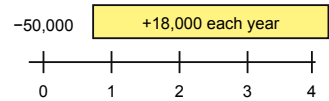
POSITION	RATE ORDER
Premium	coupon rate > current yield > YTM
Par	coupon rate = current yield = YTM
Discount	coupon rate < current yield < YTM

Semiannual: $n=2 \times \text{years}$; $C = \text{annual coupon} / 2$; $y = \text{quoted YTM} / 2$. Calculator RATE returns the half-year rate; double for quoted YTM, compound for EAR. Long maturity/small coupon → greater price risk; short maturity/large coupon → greater reinvestment risk.

10 · Worked 1:
Project Appraisal

COURSE WORKED
EXAMPLE

Given: pay \$50,000 now; save \$18,000 at each year-end for 4 years; $r=9\%$. Find NPV, IRR, payback and decide.



Ordinary annuity: outlay at $t=0$ is already a present value.

CARRY THE NUMBERS THROUGH

$AF_4, \%$ = $[1 - 1.09^{-4}] / 0.09 = 3.23972$
PV savings = $18,000 \times 3.23972 = \$58,314.96$
NPV = $58,314.96 - 50,000 = \textbf{+\$8,314.96}$
IRR solves $50,000 = 18,000 \times AF_4$, IRR
IRR = **16.37%** > 9%
payback = $50,000 / 18,000 = \textbf{2.78 years}$

Accept: NPV is positive and IRR clears the hurdle.

Payback describes recovery speed, not value, and ignores later cash after recovery.

CALCULATOR CHECK	ENTRY
cash-flow sign	$CF_0 = -50,000$
repeated inflow	18,000 for four periods
NPV / IRR	$I=9$ for NPV; solve IRR separately

WHAT THE THREE ANSWERS DO

NPV states the wealth added today; it is the decision answer. **IRR** states the project's percentage return and agrees here because this is a conventional outflow-then-inflow stream. **Payback** is a liquidity description. If this project competed with another, the higher NPV would decide even if the rival IRR were higher.

Direction checks: a higher discount rate lowers the annuity factor and NPV; an earlier saving raises value; changing the sign of CF_0 breaks both NPV and IRR. At $r=IRR$ the annuity PV must equal exactly \$50,000. At 9% it exceeds the cost by \$8,314.96, matching the stated NPV.

GENERAL EQUAL-INFLOW ROUTE

NPV = $-\text{outlay} + C \cdot AF_{n,r}$
IRR: solve $\text{outlay}/C = AF_{n,r}$
payback = outlay/C only when C is Level

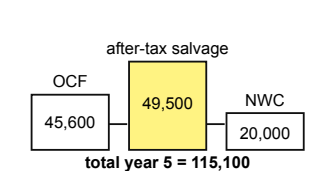
Timing variants: first saving today → multiply the ordinary value by 1.09. Delayed stream → value it one period before its first payment, then discount to $t=0$.

Multiple-choice eliminators: NPV cannot be \$58,314.96—that is the PV of benefits before the cost. An IRR below 9% conflicts with the positive NPV for this conventional stream. A payback of four years ignores that three full \$18,000 receipts already exceed the \$50,000 outlay.

11 · Worked 2: Final-Year Cash

C5 WORKED
EXAMPLE

Given at year 5: revenue \$110,000; cash costs \$50,000; tax depreciation \$12,000; tax 30%. Equipment cost \$200,000, book value \$60,000, sold for \$45,000. Release \$20,000 NWC.



Terminal cash = operating flow + after-tax disposal + working-capital recovery.

1 · OPERATING CASH FLOW

$OCF = (110,000 - 50,000)(1 - 0.30) + 0.30(12,000)$
 $= 42,000 + 3,600 = \textbf{\$45,600}$

2 · AFTER-TAX SALVAGE

Loss = $45,000 - 60,000 = -\$15,000$
ATSV = $45,000 - 0.30(45,000 - 60,000)$
 $= 45,000 + 4,500 = \textbf{\$49,500}$

3 · ASSEMBLE

year-5 CF = $45,600 + 49,500 + 20,000$
 $= \textbf{\$115,100}$

The sale below book creates a \$4,500 tax credit. The original \$200,000 does not reappear in year 5; it was a time-0 outflow. NWC comes back because inventory and receivables run down and payables settle.

SV>BV	tax on gain lowers salvage
SV<BV	tax credit raises salvage
SV=BV	no tax adjustment

ALTERNATIVE OCF AUDIT

EBIT = $110,000 - 50,000 - 12,000 = \$48,000$
EBIT(1-T) + Dep = $48,000 \times 0.70 + 12,000$
 $= 33,600 + 12,000 = \textbf{\$45,600}$

This agrees with the cash-margin-plus-shield route, so the tax and depreciation treatment is internally consistent. The \$12,000 depreciation is never a payment; it first lowers taxable profit and is then added back.

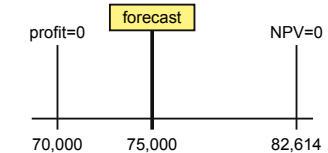
CLASSIFICATION AUDIT

NUMBER	WHY IT ENTERS
110,000	final-year incremental cash revenue
50,000	incremental cash operating cost
12,000	sets tax shield; not a cash outflow
60,000 BV	tax comparison only
45,000 SV	cash disposal proceeds
20,000 NWC	release of prior investment
200,000 cost	already paid at $t=0$; absent at year 5

12 · Worked 3: Two Break-Events

C6 WORKED
EXAMPLE

Given: line costs \$40m; 5-year straight-line depreciation to zero; price \$500; variable cost \$300; fixed cost \$6m/year; $T=20\%$; $r=8\%$; forecast 75,000 units.



Forecast clears accounting break-even but misses the value-creating threshold.

ACCOUNTING LINE

Dep = $40m/5 = \$8m$; contribution = $500 - 300 = \$200$
 $QA = (6m + 8m) / 200 = \textbf{70,000 units}$

FINANCIAL LINE

$AF_5, \%$ = 3.9927 ; $EAC = 40m / 3.9927 = \$10.0183m$
fixed after tax = $6m \times 0.8 = \$4.8m$
dep. shield = $8m \times 0.2 = \$1.6m$
 $QF = (10.0183 + 4.8 - 1.6)m / (200 \times 0.8)$
 $= \textbf{82,614 units}$

TEST THE FORECAST

annual CF at 75,000 = $(15m - 6m - 8m) \times 0.8 + 8m = \$8.8m$
NPV = $8.8m \times 3.9927 - 40m = \textbf{-\$4.86m}$

Reject at 75,000: the project reports accounting profit yet destroys value. The financial line is the correct decision hurdle because it includes the required return.

AT 75,000	AMOUNT	MEANING
Revenue	\$37.5m	$75,000 \times \$500$
Variable cost	\$22.5m	$75,000 \times \$300$
Contribution	\$15.0m	covers fixed + capital charge
Accounting profit before tax	\$1.0m	$15 - 6 - 8$
NPV	-\$4.86m	required return not earned

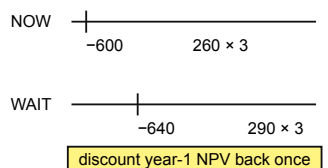
Why tax cancels in accounting break-even: after-tax profit is pretax profit $\times (1-T)$; setting it to zero still sets pretax profit to zero. Financial break-even instead works with after-tax cash and therefore includes the after-tax contribution, after-tax fixed cost and depreciation shield.

Safety margins: forecast-accounting line = 5,000 units; forecast-financial line = -7,614. Test price, cost and volume one at a time; use a scenario when inputs move together.

13 · Worked 4: Option to Wait

C7 WORKED
EXAMPLE

Given: $r=9\%$. Start now: cost 600, then 260/year for 3 years. Wait one year: cost 640 at year 1, then 290/year for 3 years. Compare at time 0.



Values dated at different start years cannot be compared directly.

START TODAY

$AF_3, \%$ = 2.5313
 $NPV_0(\text{now}) = -600 + 260(2.5313)$
 $= -600 + 658.14 = \textbf{58.14}$

WAIT

$NPV_1(\text{wait}) = -640 + 290(2.5313)$
 $= -640 + 734.08 = \textbf{94.08 at year 1}$
 $PV_0(\text{wait}) = 94.08 / 1.09 = \textbf{86.31}$

DISCOUNT AND OPTION VALUE

$86.31 > 58.14 \rightarrow \text{wait}$
option value = $86.31 - 58.14 = \textbf{28.17}$

The tempting wrong comparison is 94.08 against 58.14. That overstates waiting because the first figure is dated one year later. For any timing table, calculate at launch and then restate every result to time 0.

NODE	OPERATION
decision $\square$	keep the highest dated value
chance $\bigcirc$	Σ probability $\times$ branch value
one step left	discount one period

TIMING AUDIT

QUANTITY	DATE	COMPARABLE AT T=0?
58.14	today	yes
94.08	year 1 launch	no
86.31	today	yes

Interpret the option: waiting costs more and starts cash receipts later, but the larger annual inflow more than compensates after all values are dated consistently. The option adds 28.17 today; it is not the full delayed-project value.

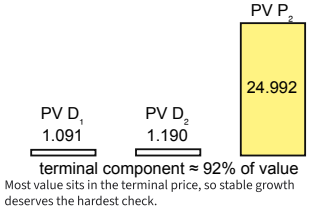
General route: for each possible start year s , calculate NPV at s from that start's cost and subsequent flows; divide by $(1+r)^s$; choose the highest present value. For a staged tree, repeat this date discipline at every node while moving from right to left.

Related options: abandon when salvage exceeds the continuation value at that node; expand only on the successful branch; stop after a failed trial when "do not invest" dominates. Option value is always the flexible project value less the otherwise identical inflexible value.

14 · Worked 5: Two-Stage Stock

C8 WORKED
EXAMPLE

Given: $D_0=\$1.00$; growth 20% for two years, then 5% forever; required return 10%.



PROJECT DIVIDENDS

$D_1 = 1.00 \times 1.20 = \$1.20$
 $D_2 = 1.20 \times 1.20 = \$1.44$
 $D_3 = 1.44 \times 1.05 = \$1.512$

TERMINAL PRICE AT YEAR 2

$P_2 = D_3 / (r - g) = 1.512 / (0.10 - 0.05)$
 $= \textbf{\$30.24}$

DISCOUNT EVERY COMPONENT

$PV(D_1) = 1.20 / 1.10 = \$1.091$
 $PV(D_2) = 1.44 / 1.10^2 = \$1.190$
 $PV(P_2) = 30.24 / 1.10^2 = \$24.992$
 $P_0 = 1.091 + 1.190 + 24.992 = \textbf{\$27.27}$

Constant 5% growth from the start would give $1.05/0.05 = \textbf{\$21.00}$; the two fast-growth years add \$6.27. P_2 uses D_3 because that is the first dividend in the stable phase, but P_2 is discounted for **two years**, its valuation date.

$g \geq r$	constant-growth formula invalid; use staged growth
no dividends	discount free cash flow at WACC; bridge EV to equity
loss-making	P/S cross-check; P/E is not meaningful

THREE DATE TRAPS

Dividend input: D_0 has just been paid, so grow once to obtain D_1 . **Terminal numerator:** P_2 uses D_3 , the first stable-growth payment. **Discount exponent:** P_2 is a year-2 value even though its numerator is D_3 , so divide by 1.10^3 , not 1.10^2 .

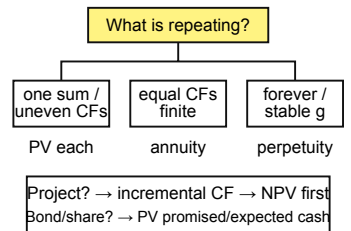
Reasonableness: the spread $r-g$ is 5%; a small change in either input moves the \$30.24 terminal price sharply. About 92% of current value is terminal, so scrutinize stable growth.

CONSTANT-GROWTH CROSS-CHECK

D_1 if 5% from start = $1.00 \times 1.05 = \$1.05$
 $P_0 = 1.05 / (0.10 - 0.05) = \textbf{\$21.00}$
fast-growth increment = $27.27 - 21.00 = \textbf{\$6.27}$

15 · Method Chooser

C2-C9 · FAST
RECALL



Shape identifies the formula; the decision rule identifies the verdict.

QUESTION WORDING	ROUTE
same payment, fixed n	ordinary/due annuity
payment forever	perpetuity; growing only if $g < r$
quoted rate, different payment frequency	APR → EAR → matching period rate
accept or reject project	incremental after-tax CF → NPV
budget cap	PI ranking, then maximise total NPV
profit=0 vs NPV=0	accounting vs financial break-even
staged uncertainty	tree: max choices, average chances, discount
temporary high dividend growth	two-stage DDM + terminal price
bond price or yield	coupon annuity + par; solve y if price given

16 · Last-Minute Error Grid

FAQS + WORKED
TIPS

- sign CF_0 negative; do not discount it
- rate period = cash-flow period
- exclude sunk and financing flows
- terminal value dated before discounting
- state accept/reject and the rule used

Five checks before selecting the multiple-choice option.

Bond order: premium → coupon > current yield > YTM; discount → coupon < current yield < YTM. Semiannual RATE is a half-year rate. **IRR:** inspect sign changes; one quoted root may be meaningless. **Working capital:** invest when required, recover at end. **Depreciation:** add the shield, not depreciation as a cash inflow.

Agency recall: approve a perk when $\text{stake} \times \text{cost} < \text{private benefit}$; raise the stake to align incentives.

Fast bond check: compare coupon rate with required yield before calculating. Coupon > yield predicts premium; coupon < yield predicts discount. If the calculated price lands on the wrong side of par, inspect the periodic rate, coupon frequency and cash-flow signs.