CHAPTER 3 PROJECT

Revenue Analysis at a Concert Venue

You are interning as a revenue analyst at a mid-sized concert venue near your university. The venue hosts events ranging from local bands to touring acts, and the management team needs help modeling ticket pricing, attendance patterns, operating costs, and revenue. You will use function notation, domain and range, linear and quadratic models, transformations, polynomial and rational functions, and rational inequalities to guide the venue's business decisions.

1. The venue's ticket revenue for a local show is modeled by $R(t) = 25t$, where t is the number of tickets sold. The venue seats 800. State the domain and range of R in this context using interval notation. Is R a function and why?

2. For a touring act, the venue uses a demand-based pricing model: $p(t) = 75 - 0.05t$, where t is the number of tickets already sold and p is the price (in dollars) of the next ticket. Evaluate $p(0), p(500),$ and $p(1000)$. What does each value mean for the venue? At what value of t does the model predict a ticket price of \$0? Is that realistic?

3. Revenue from the touring act is $R(t) = t \cdot p(t) = 75t - 0.05t^2$. Does the graph of this quadratic function, a parabola, open upward or downward? Find the vertex and interpret both coordinates in business terms.

4. The venue's total cost for hosting the touring act is $C(t) = 8500 + 12t$, which includes fixed costs and a per-ticket expense. Write the profit function $P(t) = R(t) - C(t)$ and simplify. Find the break-even points by solving $P(t) = 0$. Interpret what these break-even values mean for the venue.

5. The venue considers a VIP pricing model: $p_v(t) = 120 - 0.08t$. Write the VIP revenue function $R_v(t) = t \cdot p_v(t)$ and find the number of VIP tickets that maximizes VIP revenue. What is the maximum VIP revenue? Compare to the general admission maximum from Question 3.

6. The venue models its average monthly operating cost (in thousands of dollars) as a function of the number of shows per month s:

$$A(s)=\frac{15s+80}{s+2},\ \text{for } s\geq 0$$

a. Evaluate $A(2), A(6)$, and $A(20)$. What trend do you notice?

b. What value does $A(s)$ approach as s gets very large? Identify this as a horizontal asymptote and interpret it. What does it represent for the venue's cost structure?

7. The venue's annual attendance over five years follows the polynomial model:

$$N(x)=-50x^3+600x^2-1500x+20{,}000$$

where x is years since 2020. Evaluate $N(0)$ through $N(5)$. Describe the overall trend. During this period, in which year does the model predict peak attendance?

8. The venue's profit margin (as a percentage) depends on ticket price p and is modeled by:

$$M(p)=\left(\frac{p-15}{p}\right)\times 100,\ \text{for } p>0$$

a. Evaluate $M(25), M(50)$, and $M(100)$.

b. What value does M approach as p increases without bound? Why can the margin never actually reach this value?

c. Solve the inequality $M(p)\geq 60$ to determine the ticket prices that yield at least a 60% profit margin.

9. The venue's base ticket pricing model is $f(t) = 50 - 0.04t$. Management is considering three modifications:

$$g(t) = f(t) + 10$$
$$h(t) = 1.2 \cdot f(t)$$
$$k(t) = f(t - 100)$$

Describe how each transformation changes the pricing strategy (in plain language, not just 'vertical shift'). Which transformation would you recommend if the goal is to increase revenue without changing the rate at which price drops per ticket sold?

10. The venue director presents three models for predicting next year's monthly revenue (in thousands of dollars), where m is the month number (1 = January):

Linear : $L(m) = 8m + 40$
Quadratic : $Q(m) = -0.5m^2 + 10m + 30$

Rational: $H(m) = \dfrac{200m}{m+5}$

Evaluate each model at m = 1, 6, and 12. Which model predicts the highest December revenue? Which model's long-term behavior seems most realistic for a business that has seasonal fluctuations? What features of the venue's actual revenue cycle (summer concerts, holiday slowdowns) are not captured by any of these models?